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ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1952

Stored Products

The Pest Infestation of Stored Products (Interdepartmental) Committee had five meetings during the year. The chief subjects discussed were insecticides approved for use in grain, legislation to control the use of poisonous insecticides in grain, disinfestation of beans, methyl bromide fumigation, assessment of grain moisture content, analytical methods for extraneous matter in food stuffs, underground storage and experiments for the control of weevils in cribs. A special meeting was held with the Director of Medical Services and Deputy Director of Agriculture to discuss the use of D.D.T. in wheat. As a result of this and a further meeting called by the Director of Medical Services, at which members of the Pest Infestation Committee were present, legislation was passed specifying the kinds and amounts of insecticides which might be used in foodstuffs (G.N. 961 of 30th August, 1952).

The experimental work in progress on this subject is reported on by Miss Slow and Mr. Kockum.

Miss Slow reports:—

"A series of experiments was started to study the effects of dust diluents used with insecticides applied to grain. Whether the slipperiness to insects of various surfaces is increased by the application of inert dusts was first examined. The surfaces tested were glass, wood, aluminium (polished and unpolished) and hessian, and the dusts, bentonite, diatomite, lime, charcoal, wood ash and talc; the results indicated that all the dusts increase the slipperiness of the surfaces, talc being the most effective. On wood and hessian, none of the dusts had any effect on the ability of insects to climb. A study was then begun of the movement of insects in grain. It is hoped to elucidate some of the problems involved by a series of experiments in specially-designed apparatus. The grain conditioning plant was examined, with a view to finding a solution to the problem of reinfestation of clean grain from infested dust at the bottom of the plant. The problem was finally solved by conducting the dust and waste material outside the plant instead of depositing it at the bottom, where the insects could climb up the walls to the clean grain on the next floor. An experiment with angle barriers was also carried out. This showed that if insects climbing up a surface are confronted by an overhanging flange of sheet metal bent downwards at about 20° to the vertical, very few of them can pass it.

Experiments were carried out to find out the most effective insecticide for the disinfestation of tarpaulins and trucks used for conveying grain from Nairobi to Mombasa; the most effective was found to be an extract of pyrethrum in kerosene, but 2½ per cent D.D.T. in kerosene was also very good. In trucks with metal surfaces a spray with residual effect, such as D.D.T. wettable powder with a "sticker" added to the solution, is more effective. The following list gives the insects infesting stored products:—

ORTHOPTERA—	
Blatta orientalis	Maize.
LEPIDOPTERA—	
Sitotroga cerealella	Maize, mixed beans, sorghum.
Ephestia sericarium	Maize.
E. cautella	Maize.

COLEOPTERA—

Acanthoscelides obtectus	Mixed beans.
Calandra oryzae	Cassava, cowpeas, dolichos, green and black gram, maize, mixed beans, pigeon peas, rice, sorghum, wheat.
Callosobruchus chinensis	Cowpeas, dolichos, green and black gram, millet (with cowpeas), mixed beans, pigeon peas.
C. maculatus	Cowpeas, dolichos, green and black gram, mixed beans, pigeon peas.
Callosobruchus sp. (not in B.M.) ..	Pigeon peas.
Carpophilus dimidiatus v. ochropterus	Cassava.
C. humeralis	Cassava.
C. maculatus	Maize.
Gnathocerus cornutus	Mixed beans.
Laemophoeus minutus	Casava, maize, sorghum.
Lasioderma serricorne	Cowpeas, green and black gram, maize.
Lophocateres pusillus	Cowpeas.
Orzyaephilus surinamensis	Green and black gram, maize, wheat.
O. mercator	Sorghum.
Palorus foveicollis	Cowpeas.
Palorus sp. (not in B.M.)	Sorghum.
Piezotrachelus pullus	Cowpeas.
Rhizopertha dominica	Cassava, cowpeas, green and black gram, rice, sorghum.
Stegobium paniceum	Cowpeas, dried parsley.
Tenebroides mauritanicus	Cassava, cowpeas, dolichos, green and black gram.
T. confusum	Cowpeas, green gram, maize, rice, sorghum.
Typhaea stercorea	Maize.
Platypus penetralis	Cassava.

The hymenopterous parasites found included *Amblymerus* sp., *Aplastomorpha calandrae and Eupelmus* sp.

J. SLOW."

Mr. Kockum reports:—

"An experiment was completed using 16 bags of fumigated maize treated with 6 oz. Pyrethrum powder, 6 oz. Pysil (Pyrethrum $\frac{1}{4}$, Diatomite $\frac{3}{4}$) 6 oz. Diatomite alone and untreated maize in four replications kept at high atmospheric humidity (54 per cent to 70 per cent R.H.). This experiment was planned to give information on the action of pyrethrum at high humidity. It was however found that the results were not markedly affected by the humidity but were greatly influenced by the presence of the parasite *Aplastomorpha calandrae* How.

A 40-bag experiment using fumigated maize was also completed. This experiment was laid down to test effects of pyrethrum, pyrethrins with piperonyl butoxide, and B.H.C., and the diluents, diatomite and ground Kisii soapstone. This experiment was going for 18 months. Gamma B.H.C. at 1 p.p.m. proved to be a complete protection for more than 15 months, 8 oz.

pyrethrum powder for nine months and the pyrethrins with piperonyl butoxide preparations (pyrethrins 0.05 per cent) for six months. This experiment gave much information about the parasite on *Calandra oryzae* L. and stressed the importance of further study of complex populations. The effect of Diatomite was found to be more physical than insecticidal, its main effect being to make the grain slippery and thus difficult for weevils to spread through. These two experiments have been statistically treated and prepared for publication. The maize cribs for experimental work at the Scott Agricultural Laboratories, completed by the end of 1951, were used for a large experiment with maize on the cob. Cob maize was dusted with gamma B.H.C. in Diatomite at 10 p.p.m. and 1 p.p.m. (8 oz. dust to 9 cu. ft. cobs, counted as 200 lb. shelled maize). Other treatments were 8 oz. Diatomite, and 8 oz. Pysil. Three compartments in randomized positions were used for each treatment and for untreated controls. Cobs used as samples were mixed, placed in wire netting cages at four different levels, and three positions from outside to centre of crib. The maize was left in the cribs for six months and then shelled. The counting of samples and treatment of figures was not completed at the end of the year but the success by treating maize with 10 p.p.m. gamma B.H.C. was striking, almost complete protection being obtained. The loss in weight and damage to the grain in untreated maize was very heavy. Insects responsible were mainly *Sitotroga cerealella* and *Calandra oryzae*.

In order to find out how much gamma B.H.C. was removed in the shelling operation, maize on the cob was dusted with 100 p.p.m., 10 p.p.m. and 1 p.p.m. (9 cu. ft. counted as 200 lb. maize) and afterwards shelled in an ordinary 'Hippo' sheller (without fan) in which the maize passes over a shaking sieve. The samples were sent to the Colonial Insecticide Research Unit at Arusha, Tanganyika, for estimation of B.H.C. content. In no instance did it reach a figure above 2.5 p.p.m. even with the heavy application.

Following our recommendations based on the above experiments the Maize Control have started to use gamma B.H.C. at the rate of 1 p.p.m. in bagged maize and beans with excellent results. The Pest Control Committee has also strongly recommended the use of gamma B.H.C. in Diatomite at the rate of 12½ p.p.m. on cob maize in cribs. The increase from 10 p.p.m. of the experiment to 12½ p.p.m. arises from the use of the usual 8 oz. dose of a standard mixture locally available, containing 1.5 per cent gamma B.H.C. During the year a survey of African storage methods was started and extensive *safaris* were undertaken in the reserves of the following tribes: Kamba, Taita, Taveta, Duruma and Digo. Some new species have been found in the collections of stored products insects. A visit to Morogoro in Tanganyika was made to study underground pit silos.

S. KOCKUM."

The crib experiment described above deserves a word of comment. The results of this first experiment in the newly-built cribs surpassed expectations, since it has enabled us to recommend a practical and effective treatment for cob maize which was not known previously. If applied on all maize in the crib this should go far towards decreasing the infestation of maize weevil generally in the country. The recommendation was published in the *K.I.O. Fortnightly* (*see* List of Publications).

General Investigations

Mr. J. F. Graham, Entomologist, was based on the Scott Agricultural Laboratories. He reports as follows:—

"INTRODUCTION OF TINGIDS FOR BIOLOGICAL CONTROL

Consignments of Tingid bugs, *Teleonemia scrupulosa*, were received from Hawaii by air mail for the biological control of Lantana. The first four took

16 days or more and arrived dead. A fifth consignment contained three or four living insects and a sixth arriving in eight days contained nearly 30. These bred in the insectary but the conditions were not suitable since adults did not live long and the number of eggs laid was smaller than that expected. It is hoped that with improvements in breeding technique now being employed, such difficulties may be overcome. If the numbers increase satisfactorily, further consignments from Hawaii should not be necessary. Such shipments are only satisfactory when weather conditions in the United Kingdom are warm and are thus restricted to the summer months. These insects have been found in other countries to feed solely on Lantana and specimens at the laboratories starved to death when placed on coffee seedlings. The effect of the insects on Lantana is to produce leaf-fall resulting in defoliated plants. Repeated defoliation reduces the powers of recovery of the plant and it eventually dies. Should adequate numbers of these insects be produced at the laboratories, liberations will be made first at the Coast and later in Central and Nyanza Provinces.

Control of Wheat Green-fly (*Schizaphis graminum*)

An outbreak of green-fly in the Njoro area threatened to spread to other wheat-growing areas and an attempt was made to stop it by creating aphid-free zones on the periphery. A satisfactory spray for use by Pest Control was developed by their Entomologist, Mr. Van Someren, while members of this section tried other insecticides with a lower risk to the operators of the insecticidal machines. Messrs. Bates and Hunt applied a satisfactory spray with 5.2 oz. of gamma B.H.C. as a dispersible powder in 60 gallons of water per acre. B.H.C. dusts were satisfactory in hand-dusting machines but quite useless with drift-dusting machines.

The use of liquid sprays together with control by natural enemies reduced the infestation to negligible proportions, though a considerable acreage of late-planted wheat was lost. The possibility of future outbreaks following abnormally wet years should be considered since the species probably maintains itself on volunteer wheat in such cases.

Cotton Pests

A visit was made to the cotton areas near Kisumu in company with Mr. Geering from the Empire Cotton-Growing Corporation at Namulonge. Considerable damage by American Cotton Worm (*Heliothis armigera*) and Lygus was noticed and the need for control measures was investigated. Various cotton pests occurred on *Hibiscus cannabinus* near Nairobi and *Aphis gossypii* was controlled by spraying with TEPP.

Pests of African Crops

Mr. Lavers spent the early part of the year on a study of insect pests of African-grown crops. A special study of pests in the Nyeri area was made in April, when particular attention was paid to pests of bananas, sugar cane, sweet potatoes, citrus, maize, sorghum and pigeon peas. A search was made for *Apanteles sesamiae*—the parasite of maize stalk borer—but this was not abundant in maize from native areas. As this parasite was required for shipping to Mauritius in an attempt to control borers of sugar cane, consignments of maize stalk were sent to the laboratories from Kitale. These had an abundance of parasitized stalk borer larvæ and several shipments of *Apanteles* were made to Mauritius. These shipments were successful and over 14,000 parasites were bred and liberated in Mauritius by the end of September, 1952. In the latter part of the year Mr. Lavers spent much of his time on maize crib experiments at Kitale.

J. F. Graham."

Coreid Bug in Coconuts

Mr. P. E. Wheatley, Entomologist, was posted to the Coast in November and began work on Theraptus bugs causing coconut nut-fall at Gazi. He accompanied the Senior Entomologist to Zanzibar to familiarize himself with the work being carried out there. He began work by surveying parts of the Gazi estates to assess Theraptus damage to and to ascertain the various ant species present. Trees with Oecophylla ants showed much less damage than those with Pheidole, and Oecophylla was most numerous on sites with thick ground vegetation two or three feet high. Large-scale field trials with insecticides against this bug are planned. Rhinoceros beetle is also being studied.

Other pests investigated included *Mecocorynus loripes*, a weevil causing heavy damage to Cashew trees. This is a new pest for Kenya and may prove to be widespread along the coast.

A borer in the roots of cowpeas is also a new record. This is a Buprestid *Sphenoptera oculifrons*. A *Lymexolynid*, *Atracterocerus brevicornis*, was also found boring in Cashew trees and is the first member of this family to be recorded as a pest in Kenya.

General Insecticidal Work

Mr. P. T. Walker, Entomologist, an officer of the Colonial Insecticide Research, continued his work in this section. He reports as follows:—

"The equipment and facilities of the insecticide laboratory have continued to improve during the year, the most recent addition to insecticide testing apparatus being the Potter spray tower.

Constant temperature and humidity conditions are now available in one of the insectary rooms and time-controlled fluorescent lighting has been set up in another in an effort to improve the indoor cultures of red scale on Citrus.

Breeding

Insectary breeding of stalk borer (*Busseola fusca*) has been started and is well established. Stocks of sweet potato weevil (*Cylas puncticollis*) have been kept satisfactorily but difficulty has been experienced with indoor culture of Red scale (*Aonidiella aurantii*) on lemon seedlings.

Laboratory Work

After calibration of the Potter spray tower had shown that adequate replication of deposits could be obtained, a trial run using *Cylas puncticollis* was carried out. With a deposit of 0.8130 mgm./sq. cm. of emulsions of D.D.T., Lindane (Plant Protection, Ltd.), Aldrin and Dieldrin (Shell Chemicals, Ltd.) each at 0.5 per cent, 0.1 per cent and 0.02 per cent active insecticide, satisfactory prohibit regression lines were obtained and the following median lethal doses in mgms./ml. were obtained: D.D.T. 2.5, Lindane 3.2, Aldrin 4.7 and Dieldrin 14. Counts were made 18 hours after spraying and it is possible that the toxicity of Aldrin and Dieldrin might be increased after a longer period.

Field Work

During the Aphid outbreak on wheat and barley in the Nakuru area, a study of the estimation of Aphid populations was found to be necessary for adequate insecticide trials, and finally counts of 100 aphids before, and the number remaining after, treatment were taken as a measure of effect.

In these trials 'Agrocide' wettable powder (Plant Protection, Ltd.) gave the greatest reduction, slight phytotoxicity being evident at 8 lb./100 gallons, twice the recommended concentration. 'Pestox 101' (Pest Control, Ltd.) at

1 pint/acre of 10.5 per cent and 'Gammalin' 10 per cent Lindane emulsion (Plant Protection, Ltd.) at 1 pint 18 fl. oz./acre gave less effective but adequate control. The figure of 2 oz. lindane per acre was indicated for future work. The addition of 2 per cent wettable agent was of value. Dusting with 2.9 per cent lindane dust (Universal Crop Protection, Ltd.) at 1 lb./acre was highly effective. These figures are in agreement with a general comparison trial carried out by one of the contractors.

Observations on the plots suggest that reinfestation commences seven days after applying insecticide (Agrocide W.P.) and that a substantial population can develop in 3–4 weeks if a source of aphids is at hand.

Chafer grub experiments at Kitale on maize have been assessed. Crop yields for the three large-scale trials with different insecticides have not given adequate differences due to the absence of grubs in any quantity.

Applied as seed dressings or mixed with the fertilizer at planting time, conclusions show statistically that 'Agrocide' 10 (6.5 per cent gamma B.H.C.) at 9–10 lb./acre reduced germination to a prohibitive extent while 'Mergamma' B (Plant Protection, Ltd.) gave statistically increased yield over the controls. Over two of the trials, Aldrin 2.5 per cent dust (Shell Chemicals, Ltd.) gave an increase in yield but this could not be directly attributed to the insecticidal effect on chafer grubs. Further experiments are planned in 1953 to relate insecticide treatments more closely to grub populations in the soil.

Application Machinery

Among other types investigated, a 'Swing fog' German-made fog machine was tested and was found to have possibilities for insecticide fogging of field crops and termite nests. Further tests are needed to determine the strength and toxicity of the deposit on likely crops and the penetration through various crops under known meteorological conditions.

Small-scale hand dusting and spraying equipment has been obtained for experimental work. Larger scale equipment is on order.

P. T. Walker."

Systemic Study of Certain Economic Families

Mr. G. de Lotto has continued his work on the collections and has particularly specialized on a study of the Coccidae. This work is progressing favourably. His general identification work is of basic importance to the section. He reports as follows:—

"In 1952 the main work was the systematic study of Coccid material previously collected, and it has been possible to identify some more species so far not recorded from Kenya or East Africa. They are:—

(1) *Icerya maxima* (Newst).
(2) *Chrysomphalus pinnulifer* (Mask).
(3) *Eriococcus insolitus* (Green).
(4) *Cooleyaspis praelonga* (Newst).
(5) *Ledaspis reticulata* (Mal.).
(6) *Odonaspis secreta.*
(7) *Ischnaspis bipindensis* (Lind).
(8) *Pulvinaria inopheron* (Laing).
(9) *Pinnaspis strachani* (Cooley).
(10) *Aulacaspis tegalensis* (Zehntner).
(11) *Pseudococcus hargreavesi* (Laing).
(12) *Selenaspidus spinosus* (Laing).
(13) *Aspidiotus fissidens constrictus* (Mal.).
(14) *Gymnaspis africana* (Newst).

Four new species of mealy bugs have already been described and are awaiting publication. Another paper dealing with the description of 13–15 apparently new species of Diaspidinæ was nearly ready at the end of the year.

From a long and detailed study of the mealy bug infesting the roots of coffee, it was decided that the form should be systematically referred to *Planococcus citri*. The Coccid material collected during the year under review was rather scanty as the researches were mostly devoted to species of systematic importance. A list of more than 700 species of Coccids from the Ethiopian region has been drafted.

Identification work has been done for the Plant Protection Section as well as for other sections and Departments.

G. DE LOTTO."

Other Investigations

(*a*) Black Wheat Beetle

Following successful trials in 1951, experiments were not planned by the section against the Black Wheat Beetle, but tests with Mergamma formulations were caried out by the Agricultural Officer, Ol Joro Orok in collaboration with the suppliers of the insecticide. A supply of Aldrin dust was sent to the Agricultural Officer, Ol Joro Orok, for use in trials. Black Wheat Beetle was scarce at Ol Joro Orok, possibly due to drier weather conditions and the experiments carried out were inconclusive. In the Ol Kalou area Mergamma A was used by some farmers with reported good results but decrease in the numbers of beetles there was not definitely shown to be due to the seed dressing.

(*b*) Jacaranda Blight, *Orthezia insignis*. (Coccidae)

The control of *Orthezia insignis* by the ladybird *Hyperaspis jocosa* is, in general, successful and very good results have been reported by many gardeners. It was proposed to reduce the breeding of the ladybird to 30 per cent of its former level in April but the demand for ladybirds was such that this could not be done until August. By the end of the year liberations had been made in most districts of the Colony and large numbers had been sent to Uganda and Tanganyika. It it proposed to breed smaller numbers of ladybirds in future because of its general distribution in the settled areas. A total of more than 100,000 beetles had been liberated to the end of the year.

(*c*) *Epilachna* spp. (Coccinellidae)

Plant feeding ladybirds of the genus *Epilachna* were again reported causing damage to barley, wheat, maize, grasses, potatoes and pepino. They were generally distributed throughout the Colony and advice on their control was requested from Nanyuki, Njoro, Embu, Kitale and Machakos. The use of 5 per cent D.D.T. dust is normally satisfactory for dealing with an infestation of a small area, but for large acreages liquid spray would be more economical in application.

(*d*) Rhinoceros Beetle, *Oryctes monoceros* (Dynastidae)

This pest of coconut palms is widespread along the Coast and surveys show that it is a major pest, and considerable damage by it is apt to be overlooked by the growers. Mr. Sethi, Assistant Agricultural Officer, Msambweni, has carefully operated a number of experimental traps for Rhinoceros beetles at Gazi with good results. Decomposing coconut logs, banana stems and manure are placed in pits to which the beetles are attracted. Eggs are laid there and as the traps are cleared at intervals and the adults, pupæ and larvæ present are destroyed, a reduction of the population should result. This is an old method tried many years ago on a large scale but its value has not been shown experimentally.

The destruction of dead and dying coconut trees and a high state of general plantation hygiene, whereby breeding places such as piles of rotting vegetation are not permitted, help very considerably in reducing the beetle. This is now enforceable by law and has operated with very good results in the areas south of Mombasa. These measures should be extended to other coast areas and this can be expected to result in a general decrease of this serious pest.

(*e*) Red Spider Mites. (Tetranychidae)

Red spider mite was reported from many areas during the year and Messrs. Walker and De Lotto visited the Coast Investigational Centre to examine the infestation there on citrus trees and to advise on control. Oil emulsions are recommended for general use since the organo-phosphorus insecticides are considered too dangerous. Samples of new insecticides have been obtained and it is hoped that these can be tested in the coming year.

(*f*) Coreid Bugs on Coconuts. *Theraptus* sp. (Coreidae)

A special study of this important pest and its control was begun before the end of the year.

Miscellaneous Pests

The following pests were recorded during the year:—

Epimadiza nigra ..	Gladiolus	Nairobi.
Aonidiella aurantii ..	Rose	Nairobi.
Trioza sp.	Lemon	Soy.
Red spider	Carnations	Njoro.
Coccus hesperidum ..	Tea	Kericho.
Argyroploce leucotreta ..	Tea seed	Kericho.
Epilachna sp.	Barley, maize	Nanyuki.
Megalognatha sp. ..	Peaches	Kericho.
Dasus simplex	Wheat	Ol'Joro Orok.
Exora apicipenne ..	Wattle	Eldoret.
Dysdercus cardinalis ..	Hibiscus	Kitale.
D. pretiosus	Hibiscus	Kitale.
Spialia spio	Hibiscus	Nairobi.
Pericerya purchasi ..	Citrus	Nairobi.
Ootheca henningseni ..	Green gram	Msambweni.
Aonidimytilus albus ..	Cassava	Voi.
Epilachna sp.	Potatoes	Embu.
Xylopsocus sellatus ..	Cotton	Malindi.
Cosmopolites sordidus ..	Banana	Msambweni.
Chafer grubs	Wattle	Eldoret.
Scypophorus acupunctatus ..	Sisal	Matuga.
Aulacaspis cinammoni ..	Mango	Nairobi.
Lampides boeticus ..	Dolichos	Kabete.
Melanoagromyza phaseoli	Beans	Ngong.
Dysdercus superstitiosus	Hibiscus	Fort Hall.
D. nigrofasciatus ..	Hibiscus	Fort Hall.

Insects Identified in 1952—New Records

TENEBRIONIDAE—
Palorus foveicollis.

CURCULIONIDAE—
Peribrotus pustulosus.
Systates viridisparsus.
Tanymecus laminipes.

BRUCHIDAE—
Spermophagus kusteri.

GALERUCIDAE—
Megalognatha melanasia.

APHIDIDAE—
Macrosiphum rosae.
Toxoptera citricidus.
Sitobion africanum.
Tetraneura hirsuta.
Cerataphis variabilis.

TRYPETIDAE—
Trirhithrum occipitale.
Craspedoxantha marginalis.
Katonaia arushae.
Telaletes ochracea.

AGROMYZIDAE—
Agromyza coffeae.

Biological Control

The interest in Biological Control continues to increase, and it grows yearly more evident that East Africa is a very important source of beneficial insects for export to other parts of the world. Also a number of weeds and introduced insects are subjects for biological control, by the importation of beneficial insects.

Mr. W. F. Sellers, Assistant Director of the Commonwealth Institute of Biological Control visited the Colony in March, 1952, to report on the proposal for the establishment in East Africa of a sub-station of the Commonwealth Institute of Biological Control. Mr. Sellers had meetings with various specialists, and with the Director of Agriculture and Member for Agriculture. He stated that his impressions of the East African Colonies were very favourable, and he was enthusiastic about the possibilities that this area affords to help the Commonwealth nations with certain of their pest problems.

In connexion with the biological control of *Orthezia insignis,* the liberation of large numbers of the introduced coccinellid *Hyperaspis jocosa* has already been mentioned. In addition, the Commonwealth Institute station at Trinidad has been studying the biological control of *Orthezia* on our behalf and shipments of the Drosophilid *Gitona brasiliensis* Costa Lima have been sent. Further shipments will be required.

An introduction was made during the year, through the much appreciated help of the Board of Agriculture and Forestry, Hawaii, of the Tingid bug *Teleonemia scrupulosa* to destroy the Lantana weed. Details of this have been given. It is not known if the Scoliids introduced in 1951 to control the chafer grub in the Trans Nzoia area are established, since a special search for them has not proved possible.

The export of a good many insects was planned for 1952 or early 1953, among which may be mentioned:—

(1) Parasites of Noctuid Stalk Borers.—*Apanteles sesamiae* was successfully shipped to Mauritius and bred in large numbers by the Agricultural Department, Mauritius.

(2) Parasites of *Plutella maculipennis.*—It was planned to send to the Hawaiian Islands shipments of these parasites, including *Cadurcia plutellae,* during the year, but various difficulties were experienced. Parasites were successfully shipped early in 1953.

(3) Predators on *Orthezia insignis. Hyperaspis jocosa.*—Several consignments of this predator of *Orthezia* were sent to Uganda and Tanganyika.

(4) Snail Predators on *Acatina,* the Giant African Snail.—We have requests to ship *Gonaxis kibweziensis* to Hawaiian Islands, New Guinea and the Seychelles. Searches for the snails in the very dry conditions of 1952 were not successful, but it is hoped to obtain them in the long rains, 1953.

(5) Parasites of *Pseudococcus* sp.—California has asked us to obtain the mealy bug parasite *Tropidophryne melvillei* and it is hoped to be able to send this in 1953.

(6) Parasites of *Ceroplastes destructor.*—The introduction of parasites of this coccid is contemplated by Australia.

(7) Parasites of *Saissetia oleae.*—Interest in obtaining parasites is still exhibited by California, and further shipments are to be made when suitable infestations are found.

These projects give an indication of the great interest already being shown in the beneficial insects of this area, but the work has to be carried out at present by staff otherwise fully occupied. The number of pests carrying parasites and predators which would be of value to other parts of the Commonwealth is very great and it is sincerely hoped that the Institute will be able to open a station here.

The following specialists concerned with biological control projects visited the Laboratories or collected in parts of the country in 1952 or the first months of 1953 and it was possible to provide help, with accommodation and in other ways, to a number of them.

Mr. W. F. Sellers ..	California and Ottawa visit already mentioned.
Dr. F. J. Simmonds ..	Trinidad, biological control of *Melittomma* in Seychelles.
Mr. Krauss	Hawaii, biological control of *Oryctes* and *Acatina.*
Mr. G. S. Dun	New Guinea, biological control of *Oryctes* and *Acatina.*
Mr. R. Van den Bosch	California, biological control of *Saissetia oleae.*
Mr. E. S. Brown ..	Seychelles, biological control of *Melittomma* and *Acatina.*

Publications

Maize Storage on Farms, *K.I.O. Fortnightly,* 7th January, 1952 (2966).

Farm Storage of Grain, *K.I.O. Fortnightly,* 7th January, 1952 (2967).

Cereal Seed Importations, *K.I.O. Fortnightly,* 17th March, 1952 (2996).

The Use of Toxic Chemicals in Agriculture, *K.I.O. Fortnightly,* 30th June, 1952 (3055).

Maize Storage on Farms, *K.I.O. Fortnightly,* 22nd October, 1952 (3127).

Control of Maize Weevil in Cribs, *K.I.O. Fortnightly,* 22nd December, 1952 (3192).

Note on Damage to Grazing by Grasshoppers in Kenya, R. Le Pelley, *Bulletin of Entomological Research,* Vol. 43, Part I, March, 1952.

On the Control by Insecticides of *Heteronychus consimilis* Kolbe (Dynastidae) a Serious Pest of Wheat in Kenya, R. H. Le Pelley and E. H. Goddard, *Bulletin of Entomological Research,* Vol. 43, Part II, July, 1952.

Variation in a Character in Some Species of *Pseudococcus* (Hemiptera: Coccidae) R. H. de Pelley, Proceedings of the Royal Entomological Society of London, Series B, Vol. 21, Parts 5–6, 16th June, 1952.

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ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST, 1952

Prevalence of Diseases of Field Crops

Wheat

Wheat was attacked with unusual severity by Yellow Rust (*Puccinia glumarum*) in the seedling stage in many localities, but without affecting the mature plants except in one or two instances, where light grain resulted. *P. triticina* was observed infrequently.

Fewer specimens of "Take All' than last year were received but the disease continues to cause heavy loss in many areas. *Ustilago tritici* was received from two areas in the Highlands.

Barley

Diseases of barley included both *Ustilago hordei* and *U. nuda*. At 9,000 ft., *Puccinia glumarum* caused premature dying-off, the ears of affected plants failing to fill out. Discolouration of grain by *Helminthosporium gramineum* and one instance only by *H. teres* occurred on this crop. A *Fusarium* foot rot of seedlings occurred extensively on newly broken grass land.

Sorghum

Diseases of Sorghum comprised Rust, *Puccinia purpurea*, and Head Smut, *Sphacelotheca reiliana*.

Maize

Maize Rust, *Puccinia polysora*, was received from a number of localities in the Coast Province. Material from the Highlands was in every instance *P. sorghi*. *Helminthosporium turcicum* was generally present and occasionally severe. A series of unidentified leaf spots suggesting systemic infection occurred in some areas and is being investigated. Further instances of the bacterial disease referred to in the last report occurred in the same area. Alleged cases of root disease were due to attack by *Alectra* sp. One record only of Head Smut (*Sphacelotheca reiliana*) was received.

Grasses

Cenchrus ciliaris from the Pasture Research Station at Kitale showed an almost 100 per cent infection of *Cerebella andropogonis*, presumably growing over *Sphacelia*. Some of the heads were infected with *Fusarium heterosporum*. Similar material was also received from the Machakos plots. It would appear that these fungi are a limiting factor in seed production of this grass. *Setaria aurea* and *S. splendida* were infected in different localities by apparently different species of *Tilletia*, causing heavy loss of seed. *Cynodon dactylon* and *Paspalum dilatatum* were both severely affected by *Sphacelia*. *Puccinia cynodontis* and *Phyllachora cynodontis* occurred extensively on *Cynodon* species. *Beniowskia sphæroidea* occurred on *Pennisetum purpureum* and *P. clandestinum*. *Festuca pratensis* was heavily attacked by *Uredo* sp. Bradley Grass, *Cynodon dactylon*, on golf greens was injured by an attack of *Fusarium equiseti*. A lawn was infested with a species of *Nostoc*.

LEGUMES

Ascochyta phaseolum severely attacked the haulms of *Phaseolus vulgaris*, variety Blue Lake, and in another locality combined with a heavy attack of rust *Uromyces appendicularis*. *Fusarium* Foot Rot was received on Canadian Wonder, which variety was also heavily infested in various localities with eelworm. Mild attacks of Chocolate Spot, *Botrytis cinerea* occurred on Broad Bean.

Irrigated lucerne at 8,000 ft. was attacked by *Rosellinia necatrix*. The disease caused large bare patches of increasing size across a wide belt of the crop. The foci are thought to originate in old forest roots. Later in the year another outbreak occurred over 100 miles to the west. The common leaf diseases, rust, *Uromyces striatus*, *Pseudopeziza medicaginis* and *Pseudoplea trifolii* were of frequent occurrence during the wet seasons in many localities.

Fusarium wilt occurred on various legumes, including *F. oxysporum* on Bambara groundnuts, Broom, *Crotalaria* and Lupin. Severe attacks of Powdery mildew, *Erysiphe polygoni* occurred on *Phaseolus aureus* and on garden peas. Species of *Oidium* were also found on *Clitoria ternata* and *Tephrosia hildebrantii*. Rust on Lupins, *Uromyces appendicularis*, and *Aecidium* sp. on *Rhynchosia* sp., occurred in different localities. *Colletotrichum* sp. caused a severe stem, leaf and pod spotting of the former host. Groundnuts were severely attacked by *Cercospora personata* at the Coast. Pea seed, intercepted from Australia, was infected with *Ascochyta pisi* which fungus was also found generally on pea foliage in many districts.

POTATO

Attacks of potato blight, *Phytophthora infestans* during the year were mild in constrast with the previous year. Bacterial wilt, *Pseudomonas solanacearum*, was unusually severe in some areas and is widespread throughout the Colony. Eelworm and exposure to the sun caused storage rot of tubers. *Alternaria solani* occurred as in previous years.

HIBISCUS

Hibiscus species from a number of countries, grown at experimental stations in different parts of the country were variously attacked by disease. A vascular and collar rot disease of *H. cannabinus* and *H. diversifolius* was caused by *Fusarium oxysporum*. *Glomerella cingulata* (*Glœosporium* stage) caused severe stem cankers and leaf lesions on plants of *H. cannabinus* from imported seed from Cuba. The fungus was isolated from samples of the seed some of which showed distinct lesions.

Several varieties of *Hibiscus* in experimental plantings were attacked by *Botrytis cinerea*. The symptoms were stem cankers up to one foot in length and infected flower buds and leaves. *H. sabdariffa* was the most severely affected. Varieties of *H. cannabinus* varied in susceptibility; the most severely attacked being the variety Egyptian Teal. Less severe infections occurred on a red-flowered variety from Brazil and on certain local varieties short cankers appeared on nearly mature stems. The disease closely resembled that caused by the same fungus on *Urena lobata* and referred to in the previous report and described in the *East African Agricultural Journal*, April, 1951. As there described, infection occurs through the unopened flower buds.

Conspicuous papery white spots with a dark green or reddish margin and concentric zonation occurred on various varieties. Attempts to isolate a causal fungus failed. Premature leaf fall in the Cuba variety was attributed to cold wet weather.

Rust, *Aecidium sp.*, occurred on *H. cannabinus* in two localities.

BANANA

Panama disease of bananas, *Fusarium oxysporum cubense* was recorded for the first time in Kenya during the year. This followed closely on the record of the same disease from the Moshi district of Tanganyika by Dr. Wallace. In Kenya the disease appears so far to be confined to the Coast Province and has been confirmed from some miles south of Mombasa to north of Malindi, where it may have been present since at least as early as 1950, according to inquiries of the Arab land-owners made by the Agricultural Officer.

The most susceptible variety on the affected areas appears to be that named locally Pukusa or Bungale. Other less susceptible varieties being Buki and Boko Boko. Kiki, *Musa cavendishii,* has proved to be resistant as elsewhere, and has successfully replaced Bungale in a plantation destroyed by the disease. In general, as suggested by Mr. Jameson from Uganda experience, the sweet bananas are susceptible and cooking bananas resistant. Field trials of Kenya varieties of bananas for resistance are being carried out in Tanganyika by Dr. Wallace.

In the early stages of the survey a number of isolations and cultures were made from material sent in for diagnosis. Seven of these cultures were reported on by Dr. Gordon through the courtesy of the Commonwealth Mycological Institute where the cultures were sent in the first place. All the cultures submitted were determined as *F. cubense* by Dr. Gordon. Specimens of diseased bananas were received for diagnosis from Uganda. It is suggested that the strain of the pathogen occurring in Kenya is less virulent than that causing destruction in other parts of the world. In view of the widespread and sporadic distribution of the disease any attempt at eradication is considered unlikely to be successful and is, in any case, probably impracticable, in view of the complications of peasant land occupation.

Soft Rot, *Ceratostomella paradoxa* was the organism concerned in material received from the Highlands and, in material from Uganda, occurred together with *Fusarium cubense.* Cigar end rot, *Stachylidium theobromæ,* occurred on fruit, and a severe fruit russet also from the Highlands was attributed to a previous aphid attack.

CITRUS

Citrus nursery stock at the Coast was attacked by *Alternaria citri,* causing some premature defoliation. A collar rot in the Highlands was caused by *Fusarium equiseti* (*det.* Dr. Gordon), and a similar disease was attributed to *Diplodia natalensis.* A distortion of the apical leaves on nursery stock somewhat resembling "witches broom" was considered to be due to environmental conditions, one instance of attack by *Corticium salmonicolda* and two of Concentric Ring Blotch were received. Passion Fruit continues to be affected by Woodiness Disease of the Trans Nzoia and Sotik strains of the virus, and Brown Spot, *Alternaria passiflorœ.* One instance of Foot Rot caused by *Fusarium oxysporum* was sent in.

PINEAPPLES

Considerable loss was caused by a disease of pineapples in the main growing area in the Highlands. No indication of the disease was apparent until the fruits reached the canning factory where a fruitlet core rot was revealed on slicing the fruits. In all the material examined it appeared that the rot was caused by the entry of a species of *Penicillium* through the base of the floral cavity. The fungus involved appears to be a normal occupant of the cavity and presumably becomes enclosed during early development. Infection of the fruit tissue is thought to take place through the stigma or through growth splits as a result of certain climatic conditions and occurs to a slight extent in Kenya in normal conditions.

The trouble occurred to a lesser extent in native cultivations at a higher altitude during the same period. Later in the year the disease receded to normal incidence. From a number of fruits examined no evidence was found of the Bacterial Fruitlet Core Rot such as has been reported from the Philippines.

Pome Fruits

On Pome fruits mosaic virus disease and Crown Gall were received on apple. On apples and pears, growth cracks, and on the apples, twig blisters were associated with *Coniothecium chomatosporum*. A soft rot in a large consignment of applies from Italy was attributed to adverse storage conditions in transit. In the same consignment one instance of rot yielded *Botrytis cinerea*. A spotting of apple fruits was apparently caused by a species of *Glœosporium*.

Stone Fruits

On peach, leaf curl, *Taphrina deformans* and rust, *Puccinia pruni-spinosa* were received, the latter also occurring on plum, an apparently new host record for Kenya. Plum trees were killed by *Armillaria mellea* and Crown Gall tumours occurred on young branches of the same host.

Berry Fruits

On berry fruits, *Septoglœum mori* and *Septoria rubi* occurred on mulberry and raspberry respectively. Both downy and powdery mildew occurred on vine but less so than in the previous year. Powdery mildew was successfully controlled by *Tulisan*.

Vegetables

Tomatoes were attacked by bacterial wilt, *Pseudomonas solanacearum*, in a commercial crop and in native holdings in the Highlands. Blight, *Phytophthora infestans* caused much damage to fruit. Other diseases on tomatoes were *Phoma destructiva, Didymella lycopersici, Alternaria solani* and a fruit-rot resembling Blight, caused by a species of *Fusarium*.

Asparagus was, as usual, heavily attacked by rust, *Puccinia asparagi*, the variety said to be the supposedly resistant Mary Washington. A species of *Ascochyta* was the cause of stem cankers and bower lesions not previously seen in Kenya. *Phoma lingam* occurred on miscellaneous *Brassicas* and on kale, reappearing for the first time since 1944. It is thought to have originated from infection in the seed beds. Cabbages and kale were also attacked by *Xanthomonas campestris* and *Peronospora parasitica*, the former causing considerable crop loss. Kale in the same locality suffered from a soft bacterial rot of the stems. A *Fusarium* wilt and *Leveillula taurica* occurred on *Capsicums*. Cucurbits were in many localities attacked by *Erysiphe cichoracearum*. Diseases of onions included *Alternaria porri* attacking young plants and a bacterial neck-rot. Other diseases of vegetables were a severe leaf spot of beet caused by *Cercospora beticola* and a bacterial Crown Rot of parsely.

Ornamentals

Diseases of Ornamentals included Rust, *Uromyces dianthi* on Carnations from a number of inquirers, *Septoria dianthi* and an eelworm attack confined to the fine feeding roots. A neck rot of Gladiolus was caused by *Botrytis cinerea* and a corm rot by *Fusarium species*. Rust, *Phragmidium tuberculatum*, Black Spot, *Diplocarpon rosæ* and a leaf spot attributed to *Elsinœ rosarum* occurred on Rose. Antirrhinums were destroyed apparently by a heavy application of poultry manure. Severe defoliation of Chrysanthemums was caused by *Septoria chrysanthemi*. Freesias were attacked by *Rosellinia necatrix* and Iris by *Heterosporium gracile*. A *Septoria* species was the cause of a severe leaf spot of Persian Lilac. Berbena was almost destroyed in certain gardens by *Oidium* sp. A cultivated Orchid (*Læliocattleya hybrid*), was received with a systemic rust of a *Hemileia* species.

Miscellaneous

Japanese Radish was attacked by a Soft Crown Rot from which a species of *Pythium* has been isolated. *Cystopus candidus* caused severe shoot distortion on the same host.

Sunflowers were greatly reduced in vigour by *Alectra asperrima. Septoria helianthi* and Rust, *Puccinia helianthi,* occurred extensively on the same crop.

Cashew Nuts suffered from a serious disease associated with a species of *Glœosporium.* The disease caused cankers on the young stems and on the leaf mid-ribs. The fruit was also attacked, the lesions, on occasion, penetrating through to the kernel. False Smut of the Date Palm, *Graphiola phœnecis,* was present at the Coast. *Cerotelium fici* was received on Fig, and Mangoes affected with fruit fall and leaf spotting yielded the fungus *Curvularia lunata. Oidium mangiferæ* caused the destruction of inflorescences. The two fruit rots of pawpaw, *Ascochyta carica* and *Glœosporium* sp. occurred in the Highlands.

Castor oil plants were attacked by rust, *Melampsorella ricini* and the perfect stage of an *Uncinula* was collected on a species of *Ficus. Raphia* fruits from the Coast had cushion-like pustules of a species of *Torula. Penicillium duclauxii* and *Fusarium oxysporum* were isolated from a sisal bole rot. Tea seedlings were killed by *Fusarium oxysporum* and *Armillaria mellea.* A species of *Marasmius* was received from a mature bush.

Extensive dead areas in a *Cupressus macrocarpa* hedge were caused by *Mœnochætia unicornis.* Cankers on Cupressus wood from S. Rhodesia were probably caused by the same fungus but were too old for certain diagnosis.

Tuber rot of Cassava at the Coast was associated with *Diplodia natalensis* and from stem lesions was isolated a species of *Hendersonula* with a Torula stage in culture, different from *H. toruloidea.*

Investigational Work

Blight Resistant Potatoes

Following the appearance of new biotypes of *Phytophthora infestans* in 1951 on previously resistant varieties, originally produced by Dr. W. Black, a further selection of 12 new hybrids was received for trial early in the year. On arrival three of the four tubers of each clone were halved, suberised, and greened. Four of the hybrids did not respond to the usual treatment, the uncut tubers only surviving. Failure of the tubers to become suberised is apparently in these a varietal characteristic.

The tubers were planted in the field in April and, although growth conditions were poor, enough tubers have been lifted for a trial in 1953 long rains. Two of the hybrids appear to be unsuited to Kenya conditions. One produced a proliferation of very small tubers and another small tubers with pronounced "eye brows" and russet skin. No *Phytophthora* appeared on any of the hybrids nor on the susceptible Arran Pilot control rows. A further season's test will be required to assess their value as "Blight Resisters".

A further lot of six tubers of a virus free hybrid, immune from biotypes A and C, were received from Dr. Black. These were planted at a high altitude pasture research station for observations of virus infection of the stock and as a preliminary trial of the suitability of the station for the maintenance of virus free stocks. Virus infiltration at the Scott Laboratory is fairly rapid. A high altitude exposed site is required. The aphid "ceiling" is not known but *Aulacorthum solani* has been collected at 8,000 feet.

Of the cultures of *P. infestans* sent to Dr. Black, biotypes A, C, H and G have been identified. Strains G and H are new and have been of value in the breeding work at Corstorphine.

Previously introduced and distributed Corstorphine potatoes, although no longer immune from all biotypes in Kenya, continue to be in demand. A consignment has been sent to N. Rhodesia. It seems probable that these potatoes will continue to be of value as biotypes A and C appear to be the predominant ones in Kenya.

Wheat Stem Rust

During the year the physiologic forms of stem rust, now numbering 12, have been maintained in culture on wheat plants and have been tested and reisolated from single pustules at intervals. Owing to the seasonal difficulty in maintaining wheat plants and the rusts, part of the collection has been stored in a refrigerator. Tests at regular intervals have shown that the fungus can be kept in these conditions for as long as 8 months, without material loss of viability. Orders have been placed for ten small glass houses to replace the present unsatisfactory structures, which will enable the work to be continued under more controlled conditions. More space has been made available by the use of small cardboard square boxes to replace the pots previously used. Alkathene bags have likewise replaced the glass bell jars and have proved more effective in maintaining humidity. Trials with a wetting agent have proved that Tepol cannot, in spite of its superior wetting properties, replace saponin in rust work.

Eighty-one field collections of rust were received from the Plant Breeding Section for identification of the physiologic form present.

Forms K9 and K11 were the predominant forms found. The testing of 15 cellections was not completed by the end of the year. Seedling tests were done on 52 varieties and hybrids making a total of 176 individual tests in all. Nineteen of these wheats were of unknown reaction to any of the forms; they were tested to forms K9, K10, K11 and K12. Seven of these were resistant to K9, thirteen to K10, six to K11 and twelve to K12. Three of the Kenya hybrids were resistant to all four forms. Other wheats, some of whose reactions were known, were tested with forms K7, K9, K10, K11 and K12.

Legume Inoculants

The service of providing farmers of the Colony with legume bacterial cultures has been expanded during the year to satisfy as far as possible the growing demand. A total of 274 cultures was issued in the following groups:—

Lucerne 143, Lupin 17, Clover 10, Serradella 91, Subterranean Clover 7, Vetch 2, Soya Bean 2, Sainfoin 2, Snail Trefoil 1 and Sweet Clover 1; a total of 274 cultures. The largest quantities of seed requiring inoculant were lucerne 9,289 lb., Serradella 6,665 lb. and Lupin 3,340 lb.

A culture of Serradella inoculant locally isolated was supplied to the Plant Pathologist, Tanganyika. Seven new strains were added to the collections during the year. No. 20 from *Medicago hispida* was isolated at the request of the Pasture Research Officer. No. 22 Serradella, No. 23 Clover and No. 25 Lucerne were obtained from a firm in the United Kingdom when the locally isolated strains became contaminated. These are now being compared for efficiency with the purified local strains.

An old culture of Subterranean Clover from Australia was reisolated from a single nodule on an inoculated plant in a non-nitrogenous culture medium. The ordinary Clover strain was used in tests on Sub-Clover, but although nodulation occurred the strain appeared to be an inefficient one. A Sainfoin culture from

the United Kingdom was contaminated on arrival but induced satisfactory nodulation in agar culture, from which a pure culture was obtained. A local isolation, No. 27 from pea, produced efficient nodulation on Lentil and Vetch. Routine purity tests were done on all strains during the year.

Puccinia Polysora on Maize

Following reports of the serious outbreaks of *Puccinia polysora* on maize in West Africa, a warning was circulated to Agricultural Officers to report on any severe attacks of maize rust which might come to their notice, as it seemed not unlikely that the disease would eventually reach East Africa. These fears were realized in June when a report and specimens were received of an unusually severe attack of rust on maize at Taveta in the Coast Province. The material proved to be Uredo sori of *P. polysora* with no *P. sorghi* present. The area was was later visited with Dr. Storey of East African Agricultural and Forestry Research Organization and further material, including the teleuto stage, collected. The identification was confirmed by Dr. Bisby of the Commonwealth Mycological Institute. This is believed to be the first finding of the teleuto stage outside the Americas.

Collections of maize rust were received for diagnosis from many parts of the Colony, and from Uganda and Zanzibar. All collections from the Coast Province were *P. polysora,* from the Highlands and Nyanza *P. sorghi.* It appeared at first that the fungus was confined to the hot and humid coastal districts; later, severe attacks were reported from Uganda. Its eventual appearance in the Lake Province of Kenya seems inevitable.

Successful preliminary experiments on artificial inoculation of seedling maize plants in a glass house were done at Nairobi, with a view to developing a technique for testing for resistance and the study of physiologic forms. This work was later taken over by East African Agricultural and Forestry Research Organization and therefore discontinued.

The actual loss of crop which may ensue has yet to be assessed but in view of the undoubted susceptibility of the varieties of maize grown in Kenya the possibility of widespread destruction of the crop cannot be overlooked.

Pyrethrum Diseases

Pyrethrum Bud Disease.—The disease, which is now endemic, appeared with varying degrees of intensity throughout the pyrethrum growing areas. The incidence of the disease is, as might be expected, correlated with climatic and environmental conditions and to some extent with the age of the plant. That heavy loss can be inflicted is shown by the fact that plants growing in conditions exceptionally favourable to the disease have been found in total bud count to have 79 per cent of the buds infected.

Studies of the fungus in culture show that there is considerable variation in the mycelial character as growth proceeds. Monospore cultures on malt agar slants are at first greyish white and pulverulent, and consist of a hemisphere composed almost entirely of a tightly packed mass of conidiophores. At 2 mm. in diameter after 12 days, individual growths from abstricted conidia appear on the slant which 2–3 weeks later bears many daughter growths at the base of the agar. In 3–4 weeks the original growth changes to a mycelial form with the cessation of conidial formation. The first crop of secondary growths become mycelial after about 10 days and early become dark green to black. Sub-cultures from a culture in the mycelial state do not revert to the conidial state.

Hitherto, successful inoculations of pyrethrum with *Ramularia bellunensis* in Kenya have been done on seedling leaves (vide previous report). Early attempts

to inoculate severed buds and flowers failed as other fungi invaded the tissues when these became moribund, without any *Ramularia* having developed. During the year a series of inoculations has been done on buds in the field and in pots, using different sources of inoculum, with saponin and later Tepol as a wetter. Neither had any depressing effect on spore germination. The buds were either dipped or sprayed with the wetting solution and dry spores blown on, or the bud was treated with a suspension of spores. The plants or flower trusses were either enclosed in a glass bell jar or an alkathene bag or sleeve for 2–3 days.

Typical symptoms of Bud Disease followed inoculations from both cultures of the fungus and from spores from naturally diseased buds. The alkathene bags proved to be more satisfactory and adaptable than the glass bell jars.

From a number of inoculations, it is observed that the first external indication of infection is a discolouration of the tips of the basal whorl of the floral bracts, which occurs under the conditions of the experiment in about 20 or more days. At this stage immature sporodochia occur on the inner surface of the bracts. The appearance of sporodochia on the external surface of the bracts occurs some days later, after the whole of the bract has become discoloured, and may take as long as 38 days. In this time sclerotia are abundantly formed at the base of the inner surface of the bract. After the initial discolouration of the bracts profuse production of sporodochia and sporulation can be induced by replacing the alkathene bags. Buds inoculated when 2–4 mm. in diameter did not become visibly diseased until the ray petals were fully exposed but unexpanded, or on occasion the flowers were fully opened and the flower stalks fully elongated. In view of the large proportion of buds as distinct from flowers which are seen in the field and the length of time taken between inoculation and the appearance of the fungus, it seems that much of the natural infection takes place at an early stage of bud formation in the clump where the micro-climate is likely to be more favourable. From the appearance of fully blown flowers with only a few bracts diseased, infection does also apparently take place at later stages. Buds on mature plants were also infected using the same technique, in one instance 15 out of 17 inoculated buds becoming infected after 31 days.

Leaf infection appears to occur comparatively rarely, sometimes without any infected buds or flowers on the plant but with almost every leaf fully infected and bearing sporodochia, giving the appearance of systemic infection. Leaf infection, however, starts from the leaflet tips. Infection of buds from the leaf fungus followed the same course as that from the bud fungus.

Attempts to infect buds of *Chrysanthemum parthenium*, the host on which the original description of *Ramularia bellunensis* is based, failed. Until this has been achieved it would seem that there is some doubt as to *R. bellunensis* being the correct name for the pyrethrum fungus in East Africa.

Preliminary investigation has been started in tracing on the process of infection and development of the fungus inside the flower or bud after infection.

The facility with which artificial infection can be done makes it possible reliably to assess the susceptibility or resistance of hybrids or selections from the pryethrum stations. These are now awaited. The work will be further facilitated with the provision at an early date of a glass house in which controlled conditions will be possible. The same technique is being used in experiments on fungicides for the control of the disease. The previous field spraying trials with the newer fungicides carried out at the Molo experimental station and in the Molo district has been discontinued in favour of trials with Bordeaux Mixture under planning and supervision by E.A.A.F.R.O. following recommendations by a visiting consultant.

PLANT DISEASE SURVEY

One hundred and forty-five specimens were added to the Herbarium during the year. Eighty-four collections of herbarium material and cultures of fungi were sent to the Commonwealth Mycological Institute for determination. Identifications were received of most of these together with a few from the previous year—a total of 85 determinations (of these 52 were *Fusarium* spp. determined by Dr. W. L. Gordon).

The following were the determinations received:—

Ascochyta phaseolorum on *Phaseolus vulgaris; Aspergillus mangini* and *A. melleus* (laboratory contaminents); *Botrytis cinerea* and *Candida* Sp. on *Chrysanthemum cinerariifolium; Cerebella andropogonis* on *Cenchrus ciliaris; Chætomium cochlioides* on *Acacia molissima; Coniothyrium* Sp. on *Chrysanthemum cinerariifolium; Curvularia lunata* on *Mangifera indica; Fusarium avenaceum* on *Bromus marginatus, Cytisus scoparius, Dactylis glomerata* and *Vicia sativa; F. equiseti* on *Bothriochloa insculpta, Citrus* Sp., *Chloris gayana, Cynodon dactylon, Cytisus scoparius, Hordeum vulgare, Musa* Sp. and *Ornithopus sativus; F. graminearum* on *Triticum vulgare* (Mutant) and *Crotalaria lebrunii; F. heterosporum* on *Cenchrus ciliaris, Panicum maximum* and *Pennisetum glabrum; F. lateritium* on *Albizzia* Sp., *Chrysanthemum cinerariifolium, Citrus* Sp. and *Lupinus* Sp.; *F. moniliforme* on *Saccharum officinarum; F. moniliforme* var *anthophilum* on *Panicum maximum* and *Solanum melongena; F. oxysporum* on *Agave sisalana, Citrus* Sp., *Cucumis sativa, Dianthus canyophyllus, Lupinus* Sp., *Panicum maximum, Passiflora edulis, Solanum melongena, Thea sinensis, Triticum vulgare* and *Zea mays; F. oxysporum* forma *cubense* on *Musa* Spp.; *F. sambucinum* on *Melinis minutiflora; F. semitectum* on *Capsicum annuum, Chrysanthemum cinerariifolium* and *Hibiscus cannabinus; F. scirpi* var *acuminatum* on *Pennisetum trachyphyllum;* and *F. solani* on *Ananas commosus, Panicum maximum, Passiflora edulis* and *Petroselinum sativum; Glomerella cingulata* on *Hibiscus cannabinus* and *Musa* Sp.; *Mucor subtilissimus* on *Chrysanthemum cinerariifolium; Penicillium duclauxii* on *Agave sisalana; Periconia byssoides* (laboratory contaminent); *Puccinia polysora* (II and III) on *Zea mays; Rhizopus stolonifer* and *Sclerotinia minor* (Apothecia) on *Chrysanthemum cinerariifolium; Sclerotium delphinii* on *Pyrus malus; Sphacelotheca cruenta* on *Sorghum sudanense* and *Sorghum vulgare; S. reiliana* and *S. sorghi* on *Sorghum vulgare; Sordaria destruens* on *Chrysanthemum cinerariifolium; Tilletia ayresii* on *Panicum maximum* and *T. echinosperma* on *Setaria aurea; Ustilago cynodontis* on *Cynodon dactylon* and *U. tritici* on *Triticum vulgare.*

In addition, five rust collections new to science, sent in previous years, have now been named as follows:—

Hemileia mandevillæ on *Mandevilla* Sp.; *Puccinia cyathulicola* var *kenyensis* on *Cyathula globulifer*; *Puccinia dombeyæ* on *Dombeya nairobiensis; Puccinia kenyana* on *Vernonia cistifolia* and *Uromyces wiehei* on *Thalictrum rhynchocarpum.*

Seed Testing Laboratory

The number of samples received for testing during the year was 1,139, an increase of 252 over the previous year. They were made up as follows: Cereals 377, Grasses 297, Vegetables 57, Pulses and Millet 20, Clovers and Legumes 88, Ornamentals 121, Fibre Crops 57 and Miscellaneous 83. Purity and dodder determinations numbered 39.

The general quality of the cereal samples has, largely owing to the adverse harvesting conditions, been below the usual standard. Grain received during January and February germinated well but deteriorated when kept a further two or three months before sowing.

The term "sprouted wheat" was the cause of some controversy between farmers and millers. The seed tester was often asked to state whether sprouted grain was present. Sprouting of grain in terms of seed testing refers to the extrusion of the tip of the radicle or rootlets. The millers on the other hand, deem grain to be sprouted when only a minute crack appears over the micropyle, which indicates that already changes have taken place which make the millers down grade or reject the wheat. This has no effect on germination and is not normally referred to in the certificates unless specifically asked for.

A greater number of flower and shrub seeds was sent in by Nairobi seedsmen than in 1952. Hybrid brooms were found to need treatment with either sulphuric acid or with boiling water, the former being the more effective. Gloxinia seed was found to germinate better at 25° C. than at the fluctuating room temperature. Seeds of *Mecanopsis baileyii,* Himalayan Poppy, while apparently viable did not germinate in spite of treatment at 5° C. to simulate high altitude conditions.

Tests on seven samples of Soya Bean from the 1949 harvest were done for the Agricultural Officer (Expts.) Eldoret, germination ranging from 70 per cent to 89 per cent. Although the germination of these seeds immediately after harvest is not known, the storage period of three years can have had little effect. Purity and germination tests on several samples of Rhodes Grass, Cocksfoot, Kentucky Fescue and Zinnia were done for the Seeds Officer in connexion with the setting up of seed cleaning machines.

A series of germination tests of indigenous grasses were done for the Machakos Experimental Station from where seed of *Bothriochloa insculpta, Cenchrus ciliaris, Eragrostis superba* and *Panicum maximum* was sent from four plot treatments at intervals of one, three, six and nine months. Up to six months germination was low but increased considerably between six and nine months. Except in the D treatment *Cenchrus ciliaris* and *Bothriochloa insculpta* were heavily attacked by *Cerebella* and *Panicum maximum* by *Fusarium Eragrostis superba* from all treatments was free from disease.

Samples for testing from the Pasture Research Station, Kitale, were mainly Molasses Grass and also included indigenous species of grasses and legumes.

Glycine javanica, Alysicarpus glumaceus, Dolichos falcatus and *Stylosanthes gracilis* were treated with sulphuric acid and boiling water. *Glycine javanica* responded to sulphuric acid but with neither treatment was there much improvement in *Alysicarpus. Dolichos* and *Stylosanthes* responded well to boiling water treatment. *Setaria* and *Digitaria* species were more refractory, remaining dormant in spite of the usual methods for combating this condition.

Monthly tests for a tea company of stored chicory seed imported in 1950 have been continued, the average germination being in 1950, 66.2 per cent; 1951, 61.4 per cent; and 1952, 50.0 per cent. Cucumber seed gave a better germination at a constant temperature of 25° C. than at the fluctuating room temperature. Seeds of *Datura* and *Nicandra physaloides* from plants killed by a hormone weed killer were sent for testing by a firm of spraying contractors. The seed germinated on soil, but not on sand or filter paper. Maize seed was tested in connexion with the maize competition for the Kitale and Njoro areas.

Preliminary Investigations on Jute-substitute Fibres

Seed of various species of *Malvaceæ* has been collected from different parts of the Colony and tested for germination. So far no local seed has been found which will germinate satisfactorily without either the sulphuric acid or boiling water treatment. *Hibiscus* seed has been received from South Africa, Southern

Rhodesia, Nigeria, Cuba, Florida and Ceylon. Most of these needed no treatment to induce germination. Plants of these and various indigenous species were grown in the nursery and the seed collected for distribution. From 17 retting tests done by the Agricultural Chemist to date, the best of the indigenous species is *H. cannabinus* ex Kitale. Four more samples are now in the process of retting.

The following indigenous species were collected and grown in the nursery:—

H. cannabinus (yellow) ex Kitale.
H. panduriformis ex Nyanza.
H. ludwigii ex Molo.
H. cannabinus (yellow) ex Eldoret.
H. greenwayii ex Coast.
H. surratensis ex Coast.
H. radiatus ex Coast.
H. cannabinus (pink flowered) ex Kangundo.
H. cannabinus (blue flowered) ex Sultan Hamud.
H. cannabinus (purple flowered) ex Konza.
H. diversifolius ex Embu.

Of these *H. surratensis* has a scrambling habit, is very prickly and would be difficult to harvest. *H. radiatus* at this altitude does not exceed 8 in. in height.

H. panduriformis did not yield a very satisfactory fibre and did not produce seed; *H. greenwayii* and the two blue-flowered *H. cannabinus* have not yet been retted but appear to be satisfactory. The other species of *H. cannabinus* have a bushy habit and are prickly which makes them less satisfactory for fibre and harvesting. *H. diversifolius* is too prickly for easy handling and *H. diversifolius* var. *witteanus* has not yet developed sufficiently for a retting test. Other *Malvaceæ* collected and grown included *Malva verticillata, Pavonia schimperiana, Pavonia urens, Abutilon longicuspe* and an unidentified *Abutilon* from the Coast. Retting tests by the Agricultural Chemist will be done on these in due course.

Of the exotic species, *H. cannabinus* ex Nigeria has given the best results. The South African species did not do well in the long rains, probably due to the long sunless periods. The two species from Florida and Cuba grew well but did not exceed 6 ft. in height. *H. cannabinus* from Ceylon germinated badly and reached only a few inches in height. *H. cannabinus* from Rhodesia grew to 4 ft. and the indigenous Rhodesian species made slow growth, one dying out completely and the other coming into flower at 3 feet. Seed of the more promising species is being collected for distribution to experimental stations.

During the year 163 plant specimens were collected and pressed for the Herbarium including species of *Malvaceæ* of possible value for fibre production. Of these all but nine have been named. Seventy-one specimens were identified for officers of the Agricultural Department and members of the public.

A sample of seed from abroad intercepted by the Plant Quarantine and sent to the Seed Laboratory for analysis was found to contain 75 per cent inert matter, 14 per cent gress seed and the remainder weed seed of various European weeds. The mixture it transpired was intended for use as a poultice.

The following identifications of seed-borne fungi found on samples have been received from the plant pathological laboratory:—

CEREALS

Barley—Covered Smut, *Ustilago hordei.*

Sorghum—Smut, *Sphacelotheca reiliana.*
Helminthosporium turcicum.

Wheat—*Fusarium graminearum*, one sample with 100 per cent infection.
Epicoccum purpurascens.
Alternaria tenuis.
Septoria nodorum.

GRASSES

Bothriochloa insculpta.
Cerebella sp.—15 samples.
Fusarium graminearum and *F. equiseti*—8 samples.

Cenchrus ciliaris.
Cerebella andropogonis—18 samples.
Fusarium sp.—18 samples.

Panicum maximum.
Ergot, *Claviceps* sp. —15 samples.
Fusarium heterosporum.
Tilletia ayresii.

Brachiaria brizantha.
Sphacelia and immature ergots.

Bromus marginatus.
Fusarium avenaceum.

Dactylis glomerata.
Ergot, *Claviceps* sp.
Fusarium avenaceum.

Hyparrhenia rufa.
Cerebella sp.
Fusarium sp.

Melinis minutiflora.
Fusarium graminearum.

Chloris gayana.
Fusarium graminearum.
F. equiseti.

Setaria sp.
Tilletia echinosperma.

Other fungi occurring on grass samples during germination tests were:—
Trichurus gorgonifer.
Rhizopus stolonifer.
Alternaria tenuis.
Epicoccum purpurascens.

LEGUMES

Lupin.
Tricothecium roseum.
Fusarium lateritium.

Serradella.
Chætomium cochlioides.
Fusarium equiseti.
Trichurus gorgonifer.

Vicia.
Fusarium avenaceum.

Indigofera.
Myrothecium roridum.
Trichoderma viride.

R. M. NATTRASS,
Senior Plant Pathologist.

ANNUAL REPORT OF THE SOIL CHEMIST, 1952

Meteorological

The following summarizes meteorological data obtained at the Scott Agricultural Laboratories during 1952:—

Month	Temperatures °F.				Rainfall	Sunshine
	Absolute		Mean			
	Max.	Min.	Max.	Min.		
					inches	*hours*
January ..	83·2	50·0	76·8	54·9	0·04	209·2
February ..	85·4	51·6	81·1	55·9	0·71	267·8
March ..	90·0	51·9	83·7	56·9	0·77	270·2
April ..	84·0	54·0	78·5	58·3	15·69	210·0
May ..	79·0	53·1	75·0	57·9	11·24	195·0
June ..	84·1	45·0	71·6	53·7	—	165·9
July ..	77·0	46·5	69·2	52·2	0·33	93·2
August ..	80·4	45·3	70·5	52·0	0·59	110·0
September..	80·2	40·1	76·4	53·1	0·86	210·0
October ..	81·2	50·0	76·1	55·4	1·20	211·3
November..	79·1	53·6	73·9	56·7	2·92	196·1
December..	78·3	52·0	75·5	56·1	0·54	286·8
Year ..	90·0	40·1	75·7	55·3	34·89	2,425·5

The long rains, though heavy, fell in the short period of six weeks, and were followed by a dry period which, with little interruption during the short rains season, persisted until the end of the year.

Only limited plantings were possible in the long rains season, and of these only early plantings carried any crop. The acreage harvested was small and the yields were low. Owing to insufficient rainfall there were no short rains plantings.

Experimental Work

During 1952, the research activities of the Department expanded considerably, and with that expansion there was corresponding development of the concept of collaboration of technical officers in the planning, designing and interpretation of field experiments. Fertilizers and soil fertility studies being studies of major importance in the Department's research programme, the chemical section has been particularly concerned in such collaboration, the demands of which necessitated a decrease in the amount of independent laboratory study undertaken.

Fertilizer and Soil Fertility Studies

Early studies in the fertilizing of agricultural crops in Kenya and elsewhere in East Africa culminated in 1947 in the formulation of the "Highland Fertilizer Scheme" and the "African Fertilizer Scheme", for the further investigation of the fertilizer requirments of crops grown in the European farming areas of the Kenya Highlands and in the African occupied areas of East Africa respectively. These schemes, the former of which was undertaken by the Kenya Department of Agriculture in conjunction with Imperial Chemical Industries, and the latter by the East African Agricultural and Forestry Research Organization, both being under the technical direction of the Director, E.A.A.F.R.O., were specifically designed to operate for a defined period only, and in consequence were wound up in 1951. Under these schemes, a vast amount of soil, crop yield and fertilizer response data had been accumulated, and the more conspicuous inter-relations in the accumulated data had been examined. At the same time, the territorial coverage of the schemes had been incomplete, the range of crops in respect of which fertilizer response data were available remained small, and information on the effect of fertilizers on crop quality was scanty. Furthermore, only a limited amount of information had been obtained on the effect of the chemical composition of a fertilizer on the efficiency of the nutrient element for which it is applied, on the relative efficiency of different methods of application, on the persistence of fertilizer effects from one season to the next, or on the cumulative effects of repeated applications of the same plant nutrients in fertilizers.

Territorially, the fertilizer studies had been confined to the main European cereal producing areas of the Kenya Highlands, and to the North-western parts of the African area of Nyanza Province; information on the effect of fertilizers on crop growth elsewhere in Kenya, was obtainable only from a limited number of unco-ordinated trials, the majority of doubtful reliability, which district agricultural staff had been able to carry out. Wheat, maize, grass, sorghum and finger millet are the only crops which had been studied in any detail. Study of the effects of fertilizer composition on plant nutrient efficiency had been confined to a comparison of different phosphatic fertilizers as sources of phosphorus, and here the only comparision of importance had been between soda phosphate and the concentrated superphosphates.

Superphosphates

Incidental observations under the "Highland Fertilizer Scheme", had suggested that there were few soils in the main European cereals-producing areas of the Kenya Highlands where residual effects could be expected, at least from the more easily soluble phosphatic fertilizers. Some evidence had been obtained in the "African Fertilizer Scheme" of an accumulation effect of repeated applications of phosphates. This applied in particular to the local Uganda Rock Phosphate which had little effect when a single application was given to an annual crop, but whose effects became quite marked when repeated annual dressings were given.

The fertilizer experiment programme for 1952 was based on the findings of the "Highland Fertilizer Scheme" and the "African Fertilizer Scheme". The programme had as its aim the extension to new areas, to fresh crops and to crop quality effects, of the studies carried out under these schemes. Work was also undertaken on the cumulative effects of fertilizers and on the effect of the chemical composition of a fertilizer on its efficiency.

Fertilizer studies were extended to new areas by the laying down of simple observation exploratory trials at 29 Centres, the majority in Nyanza Province and the balance in Embu district of Central Province. The Nyanza Province trials each involved sulphate of ammonia and 40 per cent superphosphates in factorial combination on three different crops (maize, sorghum and finger millet) whilst Embu trials included farmyard manure in the treatments, each trial being on one crop only. In Nyanza Province, the results obtained from these trials confirmed the conclusion reached by Mr. G. H. Gethin Jones (Report of Fertilizer Conference, *East African Agricultural Journal,* Vol. 19, 1953, part (1)), from his examination of the results of the "African Fertilizer Scheme" trials for 1951, that cereals grown on reddish-coloured soils (i.e. soils in which the liberation of sesquioxides by weathering is well advanced), respond to superphosphates, whilst those grown on grey or black soils (i.e. soils in which weathering is as yet less advanced), respond to sulphate of ammonia, and not to superphosphates. In Embu district, the soils on which these trials were laid out were all in an advanced stage of weathering, and phosphate responses consequently were general: farmyard manure, however, was found generally superior to the fertilizers, either alone or in combination.

More elaborate and more precise trials involving sulphate of ammonia, 40 per cent superphosphate and muriate of potash at three levels in factorial combination on African cereals planted in the Long Rains season were also laid down at seven established experimental Centres in Coast Province and Central Province, with a view to obtaining a basis for the fertilizer policy for these Centres. In no trial was an appreciable potash response obtained; the response to phosphate and nitrogen varied markedly from Centre to Centre, and showed a strong connection with soil type. On soils where a pronounced phosphate effect was observed in the cereal to which it was applied, a pronounced residual effect was observed in the succeeding, usually leguminous, Short Rains crop; at the same time, this response was frequently apparent in vegetative growth only, and was not reflected in seed yield. The poor residual response in terms of seed yield of some legumes is of considerable importance in relation to the introduction of fertilizers to African agriculture as a means of stepping up production. Owing to drought, the trials at several of the Station failed in the Long Rains, and were not successfully established until the Short Rains season.

In areas of Nyanza Province, where exploratory work under the "African Fertilizer Scheme" had established that fertilizers were beneficial, 15 factorial trials were laid down with the aim of obtaining information on the most economical rates and methods of application of the beneficial fertilizers. The Mitscherlich response curves based on the results of these trials were: sulphate of ammonia $^{r}n = 541\ (1 - 10^{-0.528n})$: and double supers $^{r}p = 754\ (1 - 10^{-0.789p})$, where ^{r}n is the response in lb. per acre to be expected from an application of n cwt. per acre of sulphate of ammonia, and ^{r}p is the response in lb. per acre to be expected from an application of p cwt. per acre of 40 per cent superphosphate. These response curves give the optimum of sulphate of ammonia and 40 per cent superphosphate in responding areas under present market conditions as being about 70 lb. each; provided the existing relationship between fertilizer costs and grain prices does not deteriorate, dressings of this magnitude are reasonably profitable. At these optimum rates, drilling the fertilizers near the row just before sowing has no advantage over broadcasting before sowing.

The results of the "Highland Fertilizer Scheme" enabled firm recommendations to be prepared for fertilizing wheat and maize and tentative recommendations for the fertilizing of grassland in the European farming areas of the Kenya Highlands. These recommendations were published during 1952 in a bulletin

entitled "A Guide to the Fertilizing of Certain Crops in the Kenya Highlands". There was, however, a distinct lack of information on which to base recommendations for fertilizing other small grain cereals which are also grown in Kenya, and in the preparation of the bulletin, somewhat arbitrary conversion factors had been adopted for applying to the recommendations for wheat in order to obtain recommendations for barley and oats, and to the recommendations for maize in order to obtain recommendations for sorghum. During 1952, quantitative information regarding such conversion factors was sought in a trial in which wheat, barley and oats were combined factorially with a number of NPK fertilizing mixtures. The season proved more favourable for growth and for fertilizer responses with barley, and less favourable with oats than it was with wheat. Mitscherlich response curves for the three crops in respect of the phosphate and nitrogen treatments were:—

$$r_{wp}=795(1-10^{-0.358p}) \quad r_{bp}=1487\,(1-10^{-0.526p})$$

$$r_{op}=674\,(1-10^{-0.319p}) \quad r_{wn}=180\,(1-10^{-0.974n}) \quad r_{bn}=774\,(1-10^{-0.426n})$$

where $r$wp, $r$bp and $r$op are the responses in lb. per acre of wheat, barley and oats respectively, to a dressing of p cwt. per acre of 40 per cent superphosphate, and $r$wn and $r$bn are the responses of wheat and barley respectively to a dressing of n cwt. per acre of sulphate of ammonia. The oats did not respond to sulphate of ammonia. Calculated from these response curves, the optimum dressings of 40 per cent superphosphate at Sh. 800 per ton for wheat at Sh. 50-52 per bag of 200 lb., malting barley at Sh. 50 per bag of 180 lb., feeding barley at Sh. 36 per bag of 180 lb., and oats at Sh. 24 per bag of 150 lb., become 180-190 lb., 220 lb., 190 lb. and 80-90 lb. per acre respectively, and the conversion factors for malting barley, feeding barley and oats at these prices become, 7/6ths, 1 and ½ respectively. Similarly, the optimum dressings of sulphate of ammonia at Sh. 600 per ton for wheat, malting barley and feeding barley become, 50-60 lb., 210 lb. and 170-180 lb. per acre respectively. Before, however, such heavy applications of sulphate of ammonia to malting barley can be recommended, study of its effect on grain quality will be necessary. The greatest return by far was from applying phosphates to barley, particularly for malting. The application of fertilizers to oats or of nitrogen to wheat gave returns so small as to be of little interest to the farmer. In a nearby trial on similar soil, oats responded even less to N.P.K. Trials in other Centres in Kenya Highlands confirmed that on phosphate-responding soils, barley benefits both in respect of yield and quality from phosphate application, and that dressings of 75 lb. per acre of 40 per cent superphosphate are fully economical. Sulphate of ammonia of the same magnitude tended somewhat to reduce the quality of the sample for malting without having much effect on yield.

Practical experience, supported by a good body of experimental work, has established the dominant importance of phosphates in the growing of graminaceous crops in the European farming areas of the Kenya Highlands. At the same time, the high unit price (around £100 per ton, available P_2O_5), of the phosphate in the quick acting phosphatic fertilizers used in Kenya operates strongly against the full utilization of these fertilizers, and would have a serious effect on food production in Kenya, in the event of a marked recession in cereal prices. Consequently, the low unit price (about £10 per ton, total P_2O_5) of the phosphate in the easily accessible deposit of rock phosphate in Uganda, has caused interest in the possibilities of using Uganda Rock Phosphate as a source of phosphate to be maintained, and work to be continued in seeking agricultural methods for its effective utilization. Trials with this aim were laid down in 1952, having as their primary object the study of the long-term and cumulative effects of Uganda Rock

Phosphate, particularly in comparison with the long-term and cumulative effects of the quick-acting phosphates, and of studying the possibility of its application to grass ley as a means of building up the phosphate status of the soil with a view to economy in the more expensive froms of phosphate. Small, but better than generally anticipated responses, have already been manifested by the Uganda rock phosphate: this is in line with the conclusion drawn from a long-term observational trial laid down in 1948, and now ended, in which early recovery by grass and cereals each season from plots on a phosphate-fixing soil at Scott Agricultural Laboratories, was increased by fertilizing heavily with Uganda Rock Phosphate, but not to the same extent as when concentrated superphosphate or soda phosphate was used as the source of phosphate.

While the "Highland Fertilizer Scheme" and the "African Fertilizer Scheme" had provided a good basis for extending investigations into the use of fertilizers as a means of increasing production, no such benefit existed with regard to organic manuring and soil fertility studies. In consequence, a slower start has been necessary and few trials were ready for laying down in 1952. Work on soil fertility, however, received a great stimulus in the year, through the appointment of an American soil fertility worker to Kenya for one year's work under the "Mutual Security Administration", and the appointment of an additional and experienced Soil Chemist to Kenya, who was at the same time able to collaborate with the American worker, with a view to carrying on the work initiated by him.

With the arrival of these officers, a start at least became possible in the study of the soil properties on which fertility restoration procedures ultimately depend. Field trials during the year covered preliminary investigations into the effects of manures and mulches on annual crops and into grass breaking techniques, the latter with the aim of resolving the factors implicated in the lowness of cereal yields which is commonly observed during the first year after grass. Trials concerned with the disposal of cereal stover in areas of continuous cereal growing, which had been undertaken for a number of years, were wound up, without obtaining any very pronounced fertilizing or stubble treament effects. The earlier ploughing was carried out after harvest the better; the ploughing-in of the stubble had a slight, but not significant, depressing effect on yield but, as this effect was not overcome by even heavy applications of sulphate of ammonia, any depressing effects which did exist are unlikely to have been due to competition for available soil nitrogen. The demand for work on the problem has now declined appreciably owing to the increasing extent to which stubbles are now grazed. The demand now is more for investigation of suitable crops to undersow to the cereal, to improve the dry weather bite that it provides.

Finally, the whole fertilizer and soil fertility programme and its extension to farming practice are being co-ordinated through a series of soil surveys undertaken in collaboration with the Soil Survey Division, East African Agriculture and Forestry Research Organization. For these surveys, as the 1 : 50,000 aerial survey maps of Kenya now being published become available, the areas covered are visited by suitably qualified officers of E.A.A.F.R.O., and the Kenya Agricultural Department, in the company of the local Agricultural Officer. The party decides on and names the most important soils in the areas covered, and the locations of the soil boundaries determined during the visit are mapped. Thereafter, in the normal course of their duties, the Agricultural Officers complete the determination of the boundaries, their work being checked during periodic return visits by the Technical officers to the areas concerned. A start in this work has been made in Kiambu, Fort Hall, Machakos, Voi, Kericho, Naivasha and Thomsons Falls districts. Similar survey visits have also been made to Kilifi and Kwale districts, though the aerial survey maps of these areas are not yet avaliable.

PHOSPHATE STUDIES

The study of the long-term residual availability of single dressings of 250 lb. per acre P_2O_5 as concentrated superphosphate and soda phosphate, and of 500 lb. per acre P_2O_5 as Uganda Rock Phosphate was wound up by measuring the early phosphate uptake of cereal seedlings grown during the 1952 Long Rains, the grass on the plots having been broken in 1951. The following Table sets out, for the three test crops used, the mean dry matter yields and phosphate uptake per seedling, 18 days after germination:—

	*Control	†Rock Phosphate	†Soda Phosphate	†Double Superphosphate
MAIZE (mean of 30 plants per plot)—				
D.M. yield (mgm/plant)	490	602	560	503
P_2O_5 uptake (mgm/plant)	1·24	1·35	1·45	1·43
Barley (mean of 60 plants per plot)—				
D.M. yield (mgm/plant)	48	61	67	53
P_2O_5 uptake (mgm/plant)	·26	·33	·30	·36
RYE (mean of 60 plants per plot)—				
D.M. yield (mgm/plant)	41	61	61	51
P_2O_5 uptake (mgm/plant)	·46	·36	·51	·50

*Mean usually of 6 plots. †Mean usually of 3 plots.

The residual fertilizer effects again approached the effects observed in 1948 and 1951, and were again considerably in excess of those observed in 1950.

The accumulated results of this trial carry a strong suggestion that, even on soils of high phosphate-fixing powers, a heavy application of phosphates leads to an increase in the amount of phosphate held by the soil in forms which are available to plants. The ability of the plant to take up this extra phosphate depends on outside (e.g. climatic) factors, which are not controlled in the experiment, the result being that in one year (1950), virtually no residual effects were apparent, while in earlier and later years, (1949, 1951 and 1952), phosphate uptake from the phosphate fertilized plants was appreciably higher than from the untreated plants, the magnitude of the phosphate effect being similar in each of the three years. While the data have been inadequate for striking a complete balance sheet between added phosphate and the phosphate which has been removed from the fertilized plants at harvest, the rate of removal of added phosphate has been low, and only small proportions of the 1948 additions have been removed by the plants. Early work by Mr. Gethin Jones led him to the conclusion that water-soluble phosphates when added to local lateritic loams were changed almost immediately into forms of phosphate which are not soluble even in dilute citric acid. The results of this trial suggest that the form in which such phosphates are held, though insoluble in citric acid, are still able to supply plants with their needs. Despite the greater original dressing, the phosphate recovery from the Uganda Rock Phosphate treated plots generally has been less than from the soda phosphate and concentrated superphosphate treated plots. In explanation of this, it is suggested that the low solubility of Uganda Rock Phosphate would incline the balance of the phosphate-fixing reaction towards the bulk of the phosphate in the soil/fertilizer system remaining as rock phosphate, the consequence being that the

store of "fixed" phosphate from which the plants can draw their requirements is limited. In contrast, the solubility of the phosphate in soda phosphate and the concentrated superphosphates inclines the balance of the phosphate reaction in those cases towards the bulk of the phosphate in the soil/fertilizer system being in the "fixed" form. In consequence, the store of "fixed" phosphate from which the plants can draw their requirements will be considerable, and the uptake correspondingly greater.

Nitrogen Studies

A comparison between sulphate of ammonia and nitrate of soda as a source of fertilizer N for maize during 1952 was partly frustrated through the poorness of the Long Rains season. Soil and plant tissue analyses were, however, possible and these established that:—(1) the oven dry weight of stover from sulphate of ammonia-treated plots was slightly greater than from unfertilized or from nitrate of soda treated plots, the increase in dry weight being proportionate to the amount of sulphate of ammonia applied. The oven dry yield of stover was not appreciably affected by nitrate of soda. (2) The recovery of nitrogen in the crop stover from the sulphate of ammonia treated plots was slightly greater than from the unfertilized or from the nitrate of soda treated plots. The rate of this recovery was not significantly related to the rate of fertilizer application. The nitrate of soda had no significant effect on nitrogen recovery in the crop stover. (3) There was not significant difference between the sources of nitrogen in determining the efficiency with which plants utilized nutrient nitrogen for the production of dry matter, or for the fixation of organic carbon. (4) Soil reaction was affected only to a small extent by the fertilizer treatments. (5) Oven dry yields of stover increased significantly with increasing pH value of the soil prior to application of the fertilizer. In all, sulphate of ammonia proved slightly more effective than nitrate of soda as the source of fertilizer nitrogen. Tabulated results were:—

	D/M Yield lb./acre	N. Recovery lb./acre	%N. In D/M	C/N Ratio In Stover	Soil pH After Harvest
Unfertilized Plots ..	3,034	22·5	·723	62·8	5·45
S/A Unfertilized Plots ..	3,044	25·5	·800	56·1	5·49
N/S Unfertilized Plots ..	2,937	23·2	·813	55·8	5·41

Regression of D/M yield on rate of sulphate of ammonia application, $y=1475 + 2.87x$ (p greater than 1 per cent).

Where y=D/M yield in lb. per acre, and x=rate of sulphate of ammonia application in lb. per acre.

Regression of D/M yield on initial soil pH, $y=941x-2083$ (p greater than 5 per cent).

Where y=D/M yield in lb. per acre and x=pH value of soil.

Determination of the ammonia nitrogen content of rain water collected at S.A.L., was continued, the results from daily collection being:—

Rainfall

J	F	M	A	M	J	J	A	S	O	N	D
in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0·04	0·71	0·77	15·59	11·34	Nil	0·33	0·59	0·86	1·20	2·72	0·54

Ammoniacal N added by rain: lb./acre—

Neg. | 0·084 | 0·120 0·751 | 0·679 Neg. | 0·013 | 0·023 | 0·098 | 0·199 | 0·181 | 0·070
Mean addition of Ammoniacal N in lb. per acre per 1 in. rainfall=0·064.

The mean addition of Ammonical N in lb. per acre per 1 in. rainfall again falls within the range observed in 1950 and 1951. A marked seasonal variation in this amount has been apparent throughout the period of observations, this variation being reflected in the following month to month figures from 1950-1952, the period in respect of which full figures are available:—

Month	Mean addition of ammoniacal N in lb./acre per 1 in. rainfall at Scott Agricultural Laboratories		
	1950	1951	1952
January	·059	·125	—
February	·040	·139	·118
March	·065	·148	·156
April	·057	·079	·048
May	·055	·065	·060
June	·036	·043	—
July	·131	·103	—
August	·123	·131	·039
September	·105	·229	·114
October	·095	·058	·166
November	·050	·221	·067
December	·023	·092	·130

Lime Studies

In connexion with the initiation of critical studies in the liming of soils in Kenya, a survey was undertaken of the composition of lime products obtained from the main commercial limestone deposits in Kenya. The following results were obtained:—

Material	Neutralizing Value as % Cao	Calcium as % Cao	Magnesium as % Mgo	Sesquioxide %	Acid in Soluble Material %	Loss on Ignition %	Moisture %	Phosphates as P_2O_5 %
Whitewashlime, Makindu	62·8	58·9	9·9	1·5	4·3	30·0	0·5	0·3
Residual hydrated lime, Kisumu	66·4	67·4	2·8	2·6	3·8	24·6	6·1	0·9
Lime grit, Kisumu ..	55·7	55·4	2·4	5·0	5·2	29·9	2·1	1·2
Ground limestone, Mombasa	52·3	52·1	0·7	0·8	5·2	41·3	0·1	0·1
Burnt lime, Mombasa ..	61·1	59·9	2·2	2·2	5·1	31·2	0·1	0·75
Burnt lime, Kajiado ..	—	67·5	8·4	2·1	5·1	12·1	—	—
Voi	56·9	56·0	0·1	1·8	9·2	29·0	0·6	0·7
Voi's rock	43·1	41·7	0·1	1·8	17·6	35·4	0·8	0·1
Voi crystaline rock ..	59·4	33·0	11·1	0·3	1·6	45·4	Nil	0·6
Mtito Andei	68·4	46·6	0·3	2·3	7·2	40·8	1·1	0·8

Pineapple Studies

Pineapple growers, both in Coastal and in Highlands areas, have been concerned with chlorosis and poor growth of their plants, particularly on old cultivation. Leaf observations, analyses and preliminary nutrient injection trials following Roach (Tech. Comm. 10: Imperial Bureau of Horticulture and Plantation Crops), were undertaken with the object of collecting basic information in connexion with this condition. Two types of chlorosis were identified, and these were designated for convenience, Type A and Type B. *Type A*, is mild and had only a moderately stunting effect on the plant. *Type B*, is severe, the leaves being almost entirely pale yellow, the anthocyanin colouration of the leaves being distinctly pink, and stunting being conspicuous. Analytical data, based on dry matter, in respect of leaves from healthy plants and from plants with the different forms of chlorosis are as follows:—

Component	Healthy		Chlorrsis		
	Fertilized with sulphate of ammonia	Not fertilized with sulphate of ammonia	Type A	Type B	Type unclassified
Crude Protein %:					
Thika ..	12·1	—	—	—	7·0
Kilifi ..	12·7	—	—	—	4·5
S.A.L. ..	—	8·7	6·4	4·3	—
K_2O Kilifi ..	3·7	—	—	—	3·4
P_2O_5 Kilifi ..	0·36	—	—	—	0·19
Total Manganese:					
p.p.m. S.A.L.	—	—	—	—	—
Base	—	398	313		—
Middle ..	—	484	425	—	—
Tip	—	905	205	—	—
Total Iron p.p.m.:					
Base	—	173	284	—	—
Middle ..	—	170	460	—	—
Tip	—	205	477	—	—
Mn/Fe Ratio					
Base	—	2·30	1·12	—	—
Middle ..	—	2·80	0·92	—	—
Tip	—	4·41	1·74	—	—

These figures compare with the following figures from a spectrographic analysis on healthy and chlorotic pineapple leaves from Thika, undertaken at the Macauley Base Institute:—

	Healthy	*Chlorosis*
Manganese	420	280
Iron	162	227
Mn/Fe ratio	2.60	1.25

The leaf injection trials suggest that manganese and magnesium were beneficial, copper produced no effects at concentrations of 0.025 per cent and less and copper in stronger solutions and cobalt at all strengths tried were toxic to plants suffering from both types of chlorosis. Plants suffering from Type B chlorosis reacted much more vigorously to nitrogen than plants suffering from Type A chlorosis.

Composition of Plant Material and Stock Feeds

The following data of general interest were obtained during the year:—

PRODUCT	Moisture	Crude Protein	Ether Extract	Fibre	Ash	Remarks
	%	%	%	%	%	
Barley	9·1–13·0	9·3–17·1				P_2O_5 % ·32–·72 K_2O % ·20–·73
Bean meal	11·7	16·0	1·6	5·5	3·8	
Bean pod meal	12·3	15·9	1·7	7·3	5·1	
Castor CB93			44·8			
Castor Maunther ..			40·8			
Coffee husks	13·7	8·6	1·8	12·4	8·8	
Coffee pulp	12·7	9·3	2·1	11·7	8·2	
Copra local	5·3		40·5			
Corn cob meal	14·6	·98	·48	42·0	1·5	
Corn husk leaf	7·9	3·0	·63	34·2	2·4	
Corn husk stem	9·2	4·9	1·45	32·7	4·5	
Cotton seed		15·9				
Cotton seed cake	7·5–12·4	19·7–48·1	10·4–16·2	4·8	6·8	
Giant nettle ..	14·2	19·3				
Japanese radish	88·2–93·3	·61–2·14	·02–·06	·94–7·12	1·09–1·71	
Lucerne	14·4	22·7				B.Carotene ppm. 53–150
Lucerne meal	3·8	24·4	2·7	18·6	12·4	283
Lupin hay	10·3	22·8				
Lupin seed	10·2–15·7	32·3–39·4				
Lupin pre-flowering stage:						
Whole plant ..		20·7		30·9		True Protein % 12·6 Dig. C.P. %2·3
Leaf		29·4				True Protein % 17·8 Dig. C.P. %3·0
Stem		19·8				True Protein % 4·0 Dig. C.P. %1·7
Maize ground	10·9	9·9	4·4	1·7	1·9	
Maize seed	12·6–19·8					
Maize silage	85·5	1·4		5·0		pH. 4·6
Maize stover	5·2–19·6	3·6–5·6				
Meat/bone meal ..		26·3				
Napier grass	7·5	5·1	·81	39·1	7·1	True Protein %4·2
Native brewers grain ..	11·2	13·4	3·5	5·7	7·0	
Niger seed meal	8·3	35·2	11·7	19·6	7·4	
Oat silage	71·5	2·3				Dig. C.P. %1·3
Perennial Kavirondo Sorghum Silage ..	77·4	2·5	8·9	7·0		
Rhodes grass, early clip ..	10·3	12·0	2·0	25·4	9·3	
Rhodes grass silage ..		2·05				
Rice dust	12·5	11·2	7·9	4·8	5·9	
Silage	79·0–81·0	1·9–3·4	3·3–3·4	7·0		
Star grass silage	73·0	3·1	1·7	10·8	2·0	Dig. C.P. %2·1
Sunflower:						
Giant black ..			28·1			
Jupiter			28·8			
Mars			25·0–27·2			
Pole Star			28·1			
Cake	8·8–9·2	21·1–43·1	13·3–23·9	4·1–30·3	3·6–5·1	
Head bran	12·7–15·8	8·4–11·7	2·2–15·1	18·7–23·1	8·1–14·1	
Threshings	9·6	10·7	9·8	22·3	8·4	
Wheat:	10·4–16·7	10·5–18·6				
Equator	14·3					
294	13·0–15·1	12·2–14·1				
337	15·0					
360	12–8·15·0	12·3–13·7				
1066	13·4					
Sprouted	9·9–13·2	12·5–17·2	1·0–1·7	2·6–4·1	1·3–2·3	
Yav cake	9·5	15·3	13·4	5·3	5·7	

Composition of Manures and Fertilizers

The following data of general interest were obtained during the year:—

Product	Moisture	N	P_2O_5	K_2O	Cao	Ash	Remarks
		%	%	%	%	%	
Burnt sheep manure ..	3·1	0·10	2·6	5·7		92·4	
Coir dust ..		0·23	0·14				
Composts ..	6·1–11·5	0·77–1·05	0·40–0·53	0·56–1·71		59·5–69·8	Cit. Sol. P_2O_5 %43·1
Double supers	7·0		45·9				
Double supers caked ..	6·0		44·6				Water sol. P_2O_5 %42·1
Granular ..	3·6		48·7				43·1
Sugar by-products							
Filter press mud	8·9–11·1	1·3–1·8	0·30–0·82	0·73–0·80	5·0		
Molasses ..	23·5	0·38	0·07–0·19	1·32–5·40			
Musheragi:							
Wood ash ..	4·3		1·00	1·83			
Sisal waste ..	11·9	·46	1·78		13·5	19·9	Nitrate %·03 Cit. Sol. P_2O_5 % ·21 Cao 5·1% K_2O ·8%
Soda phosphate	·84		20·1				Cit. Sol. P_2O_5 11·6
Uganda Rock Phosphate..	1·34		20·7				3·11

Survey of Guano Resources

In connexion with a survey of the commercial potential of the phosphate guano deposits occurring on a number of Islands in the Lamu archipelago of the Northern Kenya Coast, a number of samples of deposits from these Islands have ben analysed. The phosphate content of the samples analysed was generally low, ranging from 0.18 to 17.31 per cent total P_2O_5 (compared with 24.6 per cent to 27.5 per cent for Seychelles phosphate samples analysed during the year). The samples contained very little nitrogen (0.09 to 0.36 per cent) and were highly calcareous.

Arsenic Contents of Superphosphate

In connexion with an investigation into the mysterious death of cattle through arsenical poisoning, the possibility was mooted of 40 per cent superphosphate being the source of the arsenic. The survey carried out in this connexion showed no sample of superphosphate to contain more than 0.15 per cent arsenic as As_2O_3, and the arsenic to be present in the less toxic pentavalent form.

New Zealand Flax Studies

In connexion with the development of the New Zealand flax industry, comparative tests were undertaken of the breaking strength of webbing strips made up by normal commercial spinning and weaving techniques from New Zealand

flax, sisal and jute fibres. The test strips were subjected to varying periods of rotting prior to test The results obtained are summarized as follows: —

Material	Breaking load in lb. (usually mean of three readings) after rotting for:				
	0 week	1 week	2 weeks	4 weeks	8 weeks
N.Z. flax along weft, 5 strands	120	119	164	62	48
Sisal along weft, 5 strands	100	76	109	80	68
Jute along weft, 5 strands	60	52	57	65	40
N.Z. flax along weft, 10 strands	200+	200+	200+	117	82
Sisal along weft, 10 strands	200+	145	200+	125	121
Jute along weft, 10 strands	102	83	110	105	97
Jute along weft, 20 strands	200+	157	152	140	142
N.Z. flax along warp, 5 strands	130	138	151	56	48
Sisal along warp, 5 strands	140	200+	122	76	90
Jute along warp, 5 strands	46	38	47	33	19
N.Z. flax along warp, 10 strands	200+	200+	200+	148	85
Sisal along warp, 10 strands	200+	200+	200+	200+	200+
Jute along warp, 10 strands	53	78	68	77	55
Jute along warp, 20 strands	150	125	143	123	130

Jute was very little affected by the rotting process, whilst New Zealand flax and sisal both showed signs of weakening by the fourth week; New Zealand flax showed greater loss of strength than sisal.

In a dropping test carried out at the same time, a straight weave sisal bag stood up to repeated dropping much better than either a straight weave New Zealand bag or "B" twill weave jute bag.

Publications

"A Guide to the Fertilizing of Certain Crops in the Kenya Highlands": Department of Agriculture, Nairobi, 1952.

Acknowledgments

The co-operation and interest in our work of a large number of farmers, business houses and Government Officials have given us great encouragement and assistance in the execution of our duties. The Lambert Commission, the assistance of the Mutual Security Administration, and the sojourn of Professor M. Stelly in Kenya which this assistance made possible, have all combined to stimulate our thoughts on agronomy research in general, and soil fertility in particular. It is my pleasant duty to acknowledge the part that these many persons and organizations have played in helping the Chemical Section to fulfil its functions in serving the Agricultural Department, the Kenya Government and the general public.

Finally, I would like to pay tribute to the loyal co-operation of the staff of the Chemical Section for their part in the fulfilment of these functions and to Mr. J. S. Farrell for his part in the management of the Scott Agricultural Laboratories farm in yet another typically difficult year.

EDWIN BELLIS,
Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1952

The Season—Wheat, General

In contrast to 1951, which was an abnormally wet year, the present season has been characterized by shortage of rain and bad distribution.

The monthly totals, and the number of days on which rain fell, were as follows:—

Month	1952	23 years' Average
	inches	*inches*
January	0·03 (1)	0·77
February	0·80 (4)	1·17
March	0·27 (5)	2·63
April	5·66 (20)	5·26
May	5·72 (24)	4·07
June	0·68 (6)	3·53
July	2·32 (16)	4·75
August	3·32 (20)	4·79
September	2·08 (14)	2·33
October	1·53 (11)	1·84
November	2·15 (12)	2·60
December	0·28 (7)	1·87
	24·84	35·61

The season has not been a favourable one for wheat. Ample rains in May were followed by an almost complete drought of some two months' duration, with only scattered showers thereafter. This drought, occurring as it did during the normal growing season over the Colony's main wheat belt, led many farmers to defer sowing in the hopes of good late rains which, however, failed to materialize. In consequence, although much of the early sown wheat yielded reasonable crops, late sown stands were light. In addition, the patchy nature of the rains resulted, in many cases, in uneven germination and ripening, making harvesting difficult and leading, inevitably, to loss of crop.

The Colony's wheat crop this season amounted to 1,269,107 bags of 200 lb. each (4,230,357 bushels) compared with 1,253,385 bags (4,177,795 bushels) reaped in 1951, an increase of 15,722 bags (1¼ per cent) on the 1951 figure. Corresponding acreage figures are 284,031 for this season against 293,490 acres sown in 1951. This represents 9,459 acres (3 per cent) reduction on last season's figure. The average yield per acre has risen slightly from 4.27 bags (14.2 bushels) in 1951 to a figure of 4.46 (14.9 bushels) for the present season.

The comparison may be summarized as follows:—

1951			1952		
Acres	Bags (200 lb.)	Bags/Acre	Acres	Bags (200 lb.)	Bags/Acre
293,490	1,253,385	4·27	284,031	1,269,107	4·46

In the Northern Province of Tanganyika 58,310 bags (194,367 bushels) per acre were reaped from 12,541 acres, giving an overall average of 4.65 bags (15.5 bushels) per acre. This compares with the 1951 figures of 86,452 bags (288,173 bushels) reaped from 16,650 acres, giving an overall average of 5.19 bags (17.3 bushels) per acre. It will be seen, therefore, that the acreage sown decreased in 1952 by 4,109 acres or some 24 per cent.

In addition to the non-native production, African grown wheat totalled 3,527 bags in 1951 and 3,414 bags during the present season.

In the Southern Highlands Province wheat production has suffered a further decline. From about 1,500 acres sown to the crop in 1951 the acreage this season has fallen to some 600 acres, stated to have yielded an overall average of about 4 bags (13 bushels) per acre.

Estimates show that some 60 per cent of the acreage under wheat in Kenya and over 80 per cent of that in the Northern Province of Tanganyika were sown to varieties bred by the Plant Breeding Services. The remainder is largely accounted for by introductions made by us and released to farmers after test.

Review of Main Varieties Grown

Varieties grown in the Colony during the season with their estimated acreage percentages are appended. The percentage figures for the 1951 season are given for comparison.

Variety	1951 (Actual) Acreage	1952 (Estimated) Acreage
	per cent	*per cent*
Cross 294	31·6	19·2
Sabanero	15·2	18·2
1066	9·8	13·4
Cross 318	16·4	12·1
360.H	5·0	9·3
Equator	5·3	3·8
337	Not specified	2·1
261	0·9	1·2
Regent	1·3	0·4
Unspecified	14·5	20·3
	100·0	100·0

The most noticeable change is the very considerable drop in the proportion of Cross 294, from 31.6 per cent to 19.2 per cent, and to a lesser extent of Cross 318, from 16.4 per cent to 12.1 per cent. This is largely counter-balanced by an increase in Sabanero and 1066. The reason is not far to seek and is almost, if not entirely,

due to the susceptibility to sprouting of the two former wheats which, by nature of their beardless condition and upright growth combined with an open ear habit at maturity, were severely damaged during the disastrously wet harvest of 1951. Conversely Sabanero and 1066, which are both bearded and of a drooping habit at harvest, stood up well to the wet conditions and were largely undamaged.

Considering the individual varieties, Cross 294 still retains its position as the most popular wheat, but only by a narrow margin, and accounted for some 19 per cent of the Colony's acreage. This cross is known to be susceptible in seedling tests to the last four physiologic forms of black stem rust, including the latest form K12. It was attacked by both K9 and K11 on a field scale in Kenya, and by K11 in Tanganyika, but no reports of serious damage have been received.

Sabanero has risen from third place in 1951 to second place this season with 18.2 per cent of the total acreage. 1066 occupies third place with 13.4 per cent of the acreage as against 9.8 per cent in 1951. Its gain in popularity this season has been largely due to its sprouting resistance. However, it has not yielded well in some areas and is likely to decrease in importance in 1953.

Cross 318 has dropped from second place in 1951 to fourth this season and accounted for 12.1 per cent of the acreage as against 16.4 per cent last year. It is resistant in seedling tests to the first 11 stem rust forms but susceptible to K12. It was attacked in the field and damaged by stem rust during the season and, although the form could not be determined, it is likely to have been K12.

360.H now occupies fifth place with 9.3 per cent of the acreage as against sixth place and 5.0 per cent in 1951. This wheat was attacked in the field by both K10 and K11 in 1951 and by K11 during the present season and was severely damaged on some farms. It also shows susceptibility to K12 in seedling tests. It is possible, therefore, that the acreage sown to 360.H may show a decline during the coming season. 360.H was released in 1951 and forms a good example of a new high yielding wheat which had a life of only one year before becoming susceptible to stem rust; and this stresses the need for continuous breeding work against new rust forms.

Equator, an old stand-by of the highest areas on account of its resistance to yellow ear rust, *Puccinia glumarum*, dropped from fifth to sixth place this season. Equator seems slowly and definitely to be declining in acreage over the past few years due to stem rust attack and damage. Nevertheless, the variety is still grown widely in certain localized areas to which it seems suited.

In the Northern Province of Tanganyika the main varieties grown during the season were Cross 294, 44 per cent; 261, 26 per cent; and W.1, a South African variety, 10 per cent. In 1951 the main varieties grown were Cross 294, 46 per cent; 261, 24 per cent; and Kenya Governor, 13 per cent. Thus Crosses 294 and 261 maintained their popularity in 1952. The "W" varieties increased in popularity in 1952, whilst Kenya Governor decreased during the same period.

Rust and Other Diseases

Black stem rust, *Puccinia graminis tritici*, has been prevalent during the season possibly due to the higher temperatures (associated with the partial drought) which are considered favourable to the spread of the disease. Some varieties, particularly the new wheats 318 and 360.H, were quite severely attacked and damaged on some farms. Leaf rust, *Puccinia triticina*, has also been widespread: and these two diseases are likely to have had an appreciable effect on yield.

Glume blotch, *Septoria nodorum*, and Take-all, *Ophiobolus graminis*, were less in evidence. An attack of greenfly, *Toxoptera graminicola*, did considerable local damage, particularly in the Njoro area where whole stands of both wheat

and barley were destroyed, but a return to wetter conditions fortunately provided a satisfactory control and checked the spread of the pest. Birds were very troublesome in some areas.

Physiological Forms of Black Stem Rust—Appearance of a New Form

A field survey carried out in Kenya and Tanganyika showed that in both countries the stem rust forms isolated consisted almost entirely of K9 and K11. These two are likely to be the dominant forms again this coming season with the new form, K12, possibly assuming a more important position.

A new physiologic form of black stem rust, which first appeared in Kenya in 1951, was again isolated in the Colony during the past season. This now makes the 12th stem rust form to be found in East Africa and it has accordingly been designated K12. This form was first isolated late in 1951 on a new wheat, 351.AS.1.B.2, which was being bulked up for possible release to farmers and which had shown itself resistant in seedling tests to the 11 rust forms identified up to that time. The fact that 351 was suddenly attacked by stem rust led to the suspicion that a new form had arisen.

During 1952, K12 was again isolated both from the breeding cages at Njoro on three new wheats and also in the Moiben Valley area of the Uasin Gishu District on the newly released American introduction, Carleton. K12 was not found in Tanganyika either in 1951 or 1952.

Wheats showing susceptibility to K12 in seedling tests include Cross 294 (294.M, 294.B and Kenya Settler), 318.AJ, Sabanero, Equator, Kenya Governor, 261.R, 117.A, 360.H, 338, 184, D.C. x Ceres 721 and Carleton. Varieties showing resistance include 321, 350, Regent and the newly released selection D.C. x Ceres R64. The following table sums up the reactions of a number of wheats to the three latest stem rust forms. Tests are continuing.

Variety	K10	K11	K12
Cross 294	S	S	S
Cross 318	R	R	S
Sabanero	S	S	S
360.H	R	S	R
1066	?	S	?
Equator	R	R–S	S
Regent 975·6 ..	S	S	R
117.A	R	S	S
Kenya Governor ..	R–S	R	S
D.C. x Ceres 721 ..	R	R	S
D.C. x Ceres R 64 ..	R	R	R
Carleton	?	R	S
321	S	R	R
350	R	S	R

The present position, then, is that with one exception (R64 which is resistant to all 12 rust forms), all varieties are susceptible to one or more of the latest forms. No variety, with the exception mentioned, can now be considered "safe" from stem rust attack.

The appearance of yet another rust form again makes difficult the task of recommending to the farming community suitable varieties for growing during the coming season. Advice has been published in the local Press embodying the above information and offering suggestions with the rust position in mind.

K12 shows susceptible reactions on the testers Kenya Governor and 112.A, and resistant reactions on Einkorn, Reliance, B.256.G, 58.F, which serves to distinguish it from the older forms.

Release of New Wheats

Two new wheats were released from Departmental control for sowing in 1953.

D.C. x Ceres R.64

A single plant, rust resistant, selection from the hard red Canadian spring variety D.C. x Ceres, selected at Njoro.

R.64 closely resembles the parent variety being white-chaffed and red-grained and of mid-season maturity with rather weakish straw and grain of good baking quality. Seedling tests show it to be resistant to the 12 physiologic forms of black stem rust at present identified in the Colony. It has remained free from stem rust in the field.

R.64 is suited to all areas in which D.C. x Ceres is successful, that is, from 7,000 ft. to 8,000 ft. with a growing season of 5½ to 6 months' duration. It has done well, both in small-scale tests on the Government Agricultural Station at Ol Joro Orok and on a field scale with growers in the Thomson's Falls–Ol Joro Orok areas. Like the parent variety, R.64 requires good soil and high fertility for best yields.

In view of its stem rust resistance, R.64 should prove a valuable addition to Kenya's wheats.

Carleton C.I.12064

A durum, or macaroni wheat imported direct from the United States of America and released to growers after multiplication and test.

Carleton is a late variety of tall, but stiff straw, maturing in about six months at 7,000 ft. It produces long, amber-coloured grain of good quality. Seedling tests show the variety to be susceptible to K1 and K7 physiologic forms of black stem rust, and to be resistant to the remainder with the exception of K10 and K12 which are still the subject of test. It was attacked by stem rust on some farms in the Eldoret area last season.

Carleton has done reasonably well in the Eldoret area and Moiben Valley over the past two years. It stood up well and proved resistant to sprouting in the wet harvest of 1951. It is suitable for areas in Kenya from 6,000 ft. to 7,000 ft., having a growing season of some six months' duration. It is not recommended for cultivation above 7,000 ft. on account of susceptibility to yellow rust above this altitude.

Carleton is likely to be of moderate yield only. Nevertheless, it is felt it may have limited usefulness in the areas recommended, as a macaroni variety, since it produces grain of good quality suitable for the Indian Atta trade, and may thus to some extent replace the old Golden Ball which has now virtually gone out of cultivation.

For this reason it has been decided to proceed with its release. It should, however, be planted on a limited scale in view of possible stem rust damage.

New Wheats Under Multiplication With Farmers

351.AS.1.B.2 (117.A x Regent 975.6), which had shown itself resistant in seedling tests to all eleven physiologic forms of black stem rust, was suddenly attacked on a field scale during 1951 which led to the suspicion that a new form of rust had arisen. This has now been confirmed. It was then felt that the further multiplication of 351 would have to be abandoned due to possible rust damage.

However, although 351 was attacked in the multiplication plots again during the season under review, the pustules were of the R to R-S type and no damage was suffered. As this variety shows useful baking characteristics and has yielded reasonably well at both 7,000 ft. at Njoro and 8,200 ft. on the Kinangop Plateau it may still prove a useful wheat and it has accordingly been decided to proceed with its further multiplication. Some 200 bags are now available.

Twenty-one new varieties, which had shown promise in earlier small-scale trials, were further multiplied on a field scale at Rongai, 6,000 ft. They include selections from the Crosses 261 (3), 354 (1), 359 (7), 360 (6) and the four Durums R.L. 1742 (Bald Medeah x Iumillo-Mindum), and R.L. 3047 (R.L. 1742 x Carleton[2]), both from Canada; and Russo and Argelino, both from Portugal. Crosses 354 and 359 show nicely balanced baking characteristics with a slight leaning towards distensibility; but Cross 360 exhibits excessive stability in relation to its general strength.

Insofar as the Durum varieties are concerned, there is a limited market for this class of wheat for making flour and other products suitable for the Indian Atta trade. It was hoped that these four Durums would be useful for this purpose but tests now show that, although they possess the necessary high stability required for this type of flour, all are too low in general strength to be acceptable. It is doubtful, therefore, whether they will be carried on further.

The most successful of these varieties will again be multiplied during the coming season.

Wheat-breeding at the Plant Breeding Station, 7,100 ft., and the Rongai Sub-station, 6,000 ft.

INTRODUCTIONS

The following trials were carried out at the Plant Breeding Station unless otherwise stated. To save space only mention of the more outstanding material is made.

1950 *Introductions*

From the Dominion Cerealist, Ottawa, Canada.—Hope x Timstein (C.A.N. 3751) and Mida x Cadet (C.A.N. 3668) were further multiplied. Both stood well, remained free of rust but did not look heavy yielders. The former exhibited excellent baking characteristics and came 13th out of 25 entries in the yield trial at Njoro.

From the Waite Agricultural Research Institute, Adelaide, Australia.—Glenwari, which was slightly attacked by stem rust of the R-S type in 1951, suffered scattered rust attack of the S type and was also badly infected with leaf rust, *P. triticina.* Nabawa x (Riverina x Hope) remained free from stem rust as in 1951 but suffered badly from orange and yellow leaf rust attacks which destroyed the foliage.

From the United States Department of Agriculture, Washington, D.C.—These varieties, referred to in the 1951 report, were unfortunately destroyed in a fire which burnt one of the stores.

1951 *Introductions*

From the College of Agriculture, Potchefstroom, South Africa.—The 41 selections from *T. vulgare* x *T. Timopheevi* were reduced to two which appeared of most interest. 153-M-M and 466-4-M-M-1-M remained free from stem rust but the latter was rather weak in the straw. They gave grain bushelling 64 lb. and 66 lb. respectively.

From the Ministry of Agriculture, Buenos Aires, Argentine.—Of the 18 varieties introduced in 1951, four will be carried on for further trial. They are Benevenuto Inca, Klein Orgullo, Sinvalocho MA, and Klein Titan. All were attacked to varying degree by stem rust.

From the U.N.E.S.C.O., East Asia Science Co-operation Office, Shanghai, China.—Pi Yu (Quality), the only variety not destroyed by stem rust in 1951, was slightly attacked this season. It has excellent straw, but does not look a heavy yielder. It gave grain of 62 lb. bushel weight.

From Dr. R. F. Peterson, Dominion Laboratory of Cereal Breeding, University of Manitoba, Canada.—The two Durums, R.L. 1317 and 1642 (both Iumillo x Mindum) remained free from stem rust but were attacked by yellow ear rust, the first having some 30 per cent of the florets infected. Exchange (R.L. 1803) and Klein 33 (R.L. 1885) were only slightly attacked by stem rust and gave grain of 64 lb. and 65 lb. bushel weight respectively. Chinese (R.L. 1815), which remained free from rust in 1951, and Illinois (R.L. 1593) were badly attacked by stem rust. Exchange suffered from browning and spotting of the foliage as in 1951.

From the College of Agriculture, Bombay, India.—As in 1951 all three introductions Nos. 113, 116 and 197 remained free from stem rust and looked attractive. They will be carried on for further observation in 1953.

From the Wheat Research Station, Hosangabad, India.—Hybrids Nos. 2, 4 and 6 remained free from stem rust. The remainder, Nos. 1, 3, 5, 7 and 8 suffered slight attack with pustules of the R type. In addition Nos. 1, 2, 4, 6 and 8 were attacked by orange leaf rust. Nos. 2 and 7 seem of most promise. All will be carried on for further observation.

1952 *Introductions*

From the Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—Six R.L. 2265 x Redman[3] crosses. All were attacked slightly by stem rust but selection within the cultures was possible. Thatcher x (R.L. 2265 x Redman[3]) which is R.L. 2651, grew poorly and was attacked by stem and orange leaf rusts. R.L. 3047 and R.L. 3048 (R.L. 1742 x Carleton[2]), although very tall, were most attractive, remained free from rust and gave hard, translucent grain. Both are re-introductions of material already under field scale multiplication. Mindum x Carleton (R.L. 3093) was attacked by R type stem rust.

From L. R. Waldron, State College, Fargo, N. Dakota.—Five *Aegilops squarrosa* x *T. Timopheevi* crosses, highly resistant to leaf and stem rusts, except American stem rust race 15B. Nos. 3.3.35.1, 3.6.34 and 1.11.6.43 were slightly attacked by stem rust with pustules of the R-S type. Nos. 3.6.56 and 1.14.2 had a somewhat heavier infection.

Lee and Vernum were badly attacked by stem rust; Rushmore (L.D. 306) and No. 4028 had lighter infections. Segregation for rust susceptibility was apparent and selections were made in some cases.

All will be carried on for further observation.

From the Director of Agriculture, Crop Research, Bombay, Poona.—Ten Hofed x Niphad and Kenya E144 (58F) crosses showing promise of rust resistance and other agronomic characters. They were only slightly attacked by stem rust but all suffered badly from orange leaf rust which destroyed the foliage in some cases.

From Dr. R. F. Peterson, Dominion Laboratory of Cereal Breeding, Winnipeg, Manitoba.—McMurachy x Exchange (R.L. 2265.55) was badly attacked by stem rust and set no grain.

From the Central Experiment Station, Algeria.—Various Durums and bread wheats, chiefly Pusa x Florence and Florence x Aurore crosses. The best will be carried on to 1953.

From the United States Department of Agriculture, St. Paul, Minnesota.—Surpresa, Frontana, Premier x Bobin² Gaza (N.S. II-39-2), Timstein x Newthatch (N.S. II-42-22), Lee (C.I. 12488), and Kentana. The first two were destroyed by stem rust. The remainder were slightly attacked only and will be given further test.

From the Department of Agriculture, Sydney, N.S. Wales, Australia.—Festival (C 15418) was badly attacked by stem rust and yielded poor, shrivelled grain.

From Stazione Fitotechnica, Lombardo, Italy.—Four Mentana x *Aegilops ovata* lines. Line C, although attacked by stem rust, gave good grain. The remainder were destroyed by stem rust.

From Canada (through Pasture Research Officer—Molo).—T. turgidum x *A. intermedium, T. vulgare* (Kharkov) x *A. intermedium*, and *T. dicoccum* (Vernal) x *A. intermedium.* None germinated.

From N. Carolina State College, Raleigh, N. Carolina.—Atlas 50, Atlas 66, Redhart. All were covered with stem rust and destroyed.

From Dr. R. G. Shands, Wisconsin.—Seven *T. vulgare* x *T. Timopheevi* crosses and back-crosses. They were attacked to a varying degree by stem rust but most gave reasonable grain. They will be tested further.

From the Director of Agriculture, Cyprus.—11 wheats chiefly Durums. They were Yiannakis, B. X I.P.I., Kyperounda and Psathas crosses. Most were destroyed by stem rust.

From F.A.O., Addis Ababa, Ethiopia.—8 wheats all of which were destroyed by stem rust. They were La Siegle I to IV, Froment I and II, and two un-named varieties.

From the College of Agriculture, Potchefstroom, South Africa.—Penkop, Magaliesberg, Maluti, Goudveld and White Spitskop. All were badly attacked by stem rust and, with the exception of the last two, were destroyed.

From the Waite Agricultural Institute, Adelaide, Australia.—Macquarie was totally destroyed by stem rust.

From Department of Agriculture, Asmara, Eritrea.—Five varieties all destroyed by stem rust, Nos. E.W.3, A.10, H.23, P.20 and R.18.

From Dr. I. A. Watson, Sydney, Australia.—Three wheats, Khapli derivative K.D. 1451, Kawvale-Marquillo x Kawvale-Tenmarq (C.I. 12128), and Nebraska 60 x Mediterranean-Hope (C.I. 12500). The first had a fair stem rust attack and gave very poor grain. The other two were longer in maturity and were still growing nine months after sowing.

These wheats were received somewhat late for sowing at Njoro and it cannot be considered that they have had a fair test.

From Dr. C. O. Johnston, Manhattan, Kansas.—17 wheats consisting of Mediterranean, Hope, Tenmarq and similar compound crosses.

All were received very late, failed to ear, and will be re-sown in 1953.

Cage Material

One hundred and forty new crosses were made using local wheats and promising introductions with the emphasis on securing resistance to the latest four rust

forms K9 to K12. In addition, 77 back-crosses were carried out in continuation of the 1948/51 programme. This programme has as its object the transference of a single characteristic from one parent to a second otherwise desirable parent which lacks it. These crosses will not be listed here, as has been customary in earlier reports, owing to considerations of space. The number of seeds set in these crosses was 14,228 out of a possible total of 23,735 giving a set of some 60 per cent.

Cross 390 (291.J.1.I.1 x 261.S.10.C.2.D) advanced to F.4. All families were attacked in varying degrees by stem rust and it would appear that this cross may have to be discarded as both parents are susceptible to K9.

The remaining cage material, mentioned in the 1951 report, had to be held over due to lack of staff.

Wheats Under Initial Multiplication

Selected segregates from the crosses 354 (Warigo x Sterling), 356 (184.P.2.A.1.F x 192.Q.2.A.L), 357 (184.P.2.A.1.E x 294.AN.4.A.1), 358 (184.P.2.A.1.E x 294.B.2.A.3), 359 (291.J.1.I.1 x 184.P.2.A.1.E.), 360 294.M.7.C.6.C x 184.P.2.A.1.E), and 367 (Warigo x 184.P.2.A.1.F) were further multiplied and tested in yield trials. It has already been mentioned that the most successful of these segregates, chosen as a result of the 1951 trials, have been multiplied on a field scale at Rongai during the season.

Selected material from Cross 362 (Equator x 294.M.7.C.6.C), which was promoted to the first multiplication stage in 1951, was further increased during the year. All families grew well and showed resistance to yellow ear rust but were attacked to a greater or less extent by stem rust. As both parents are susceptible to one or more of the latest rust forms, the future of this cross seems very uncertain.

The following introductions, which had done well in earlier trials, were further multiplied—Granadero Klein from Southern Rhodesia; 466.4.M.M.3, 153.M.M and 466.4.M.M.1.M from South Africa; R.L. 2150 and R.L. 2200 (Marquis[2] x *Agropyron elongatum*); R.L. 1742 (Bald Medeah x Iumillo-Mindum); R.L. 3047 and R.L. 3048 (R.L. 1742 x Carleton[2]); Hope x Timstein C.A.N. 3751; and Mida x Cadet C.A.N. 3668 all from Canada: Russo and Argelino from Portugal. As previously mentioned the four Durums grown at Rongai will probably have to be discarded owing to their unsuitability for the Atta trade. In addition, 466.4.M.M.3 will also have to go as tests have shown that its flour is characterized by high stability and low general strength.

Mukhtar and Giza from Egypt grew very poorly at Rongai and suffered badly in the dry weather. As their performance in previous seasons has been disappointing they will now be discarded.

Yields of New Wheats Under Test

The following table gives yields of some of the newer hybrids at Njoro 7,100 ft., and Eldoret 7,000 ft., in comparison with a number of the more promising introductions. At Njoro it is interesting to note the general high yielding ability of Cross 360, whereas Cross 359 seems definitely poorer. Cross 354 is of note since three segregates figure in the top half of the list and one has come top of the trial. This cross is characterized by a nice balance of baking characteristics, with a leaning towards distensibility, whereas Cross 360 exhibits high stability in relation to its general strength.

At Eldoret a wheat variety trial was laid down for the first time in the area, the object being to find varieties suitable for the thin lateritic soils of the Uasin Gishu Plateau. 354.P.3.B.2.B heads the list with two further strains of the same cross occupying the second and third places. In contrast, Cross 360 has done poorly

and generally occupies places towards the bottom of the trial. Whilst it would be unwise to place too much reliance on the results of one season, it would seem as if this cross is not so suited to conditions in the Uasin Gishu. Trials will continue.

No yield trial was laid down at Rongai.

WHEAT YIELD TRIALS—NJORO AND ELDORET

VARIETY	NJORO		ELDORET	
	Yield*	Position	Yield*	Position
354.P.3.B.2.B	8·10	1	7·39	1
360.H.3	7·90	2	4·98	13
360.F.8.X.5.B	7·80	3	—	—
360.H	7·50	4	4·98	13
360.G.1.B.3	7·43	5	5·21	12
360.F.8.X.6.B	7·32	6	—	—
354.P.3.B.5.B	7·30	7	5·93	3
360.F.8.X.2.B	7·07	8	—	—
363.K.1.B.2	7·01	9	—	—
360.F.8.D.3	6·94	10	5·92	4
354.P.3.D.3.A	6·85	11	5·58	8
359.AV.1.B.1.A	6·85	—	5·74	5
Hope x Timstein	6·83	13	4·62	16
359.AV.1.C.2.C	6·79	14	5·72	6
354.P.3.D.3	6·78	15	5·52	10
359.AK.3.F.4.B	6·76	16	4·66	15
357.P.2.B.1	6·57	17	5·45	11
354.P.3.D.4	6·56	18	5·57	9
359.AK.3.A.5.A	6·56	—	4·52	17
354.P.3.B.10.B	6·40	20	6·25	2
Granadero Klein	6·22	21	5·60	7
360.E.13.C.7	5·80	22	3·13	19
360.E.13.C.7.D	5·77	23	2·86	20
357.AB.1.D.1	5·65	24	4·46	18
360.E.13.C.7.H	5·07	25	2·50	21
Mean	6·79	—	4·82	—
Significant differences—				
P.05=	0·92	—	1·03	—
P.01=	1·23	—	1·36	—

*Yield in bags of 200 lb. net per acre.
Low yields due to drought.

Wheat-breeding at the Low and High Altitude Sub-stations

SCOTT AGRICULTURAL LABORATORIES, 5,700 FT.

No wheat breeding work was carried out at this sub-station during the season.

MOLO 9,300 FT., OL JORO OROK 7,800 FT., AND N. KINANGOP 8,300 FT.

It will bear repeating that the aim of the high altitude breeding work is to produce varieties of good yielding power suited to the longer season which obtains in these areas. Over 7,000 ft., resistance to yellow ear rust, *Puccinia glumarum*, is essential.

In the Molo cage, selection continued in the two crosses 384 (Equator II x Kenya Ploughman) and 385 (Equator II x 318.AJ.4.A.1) which have now advanced to F.3. They have as their object the combination of the high yield and straw qualities of Cross 318 with the vigour and yellow rust resistance of Equator. Most of the families are considered to be too tall and selection was concentrated on the shorter strawed cultures possessing the other qualities desired. After harvest, baking tests on the discarded grain showed, as rather expected from the parentage of the crosses, a marked stability in relation to their general strength.

The single plant selections within the varieties 318, 1066, Equator and D.C. x Ceres, made in 1949 in an attempt to improve straw strength and yellow ear rust resistance, were multiplied a stage further and those showing most possibility kept on for sowing in 1953. The selected segregates in the crosses 361 (Equator x 117.A) and 362 (Equator x 294.M.7.C.6.C) which were promoted last season to the first multiplication series were again under observation both at Molo and Ol Joro Orok. Further selection was carried out on the basis of growth vigour and rust resistance, and cultures passing this test were carried forward to 1953.

At Ol Joro Orok, D.C. x Ceres and its two selections head the list, followed by two strains of the new Cross 362 (Equator II x 117.A). This is rather a different picture from that shown last season when 350.AD.9.C.2 came top and the D.C. x Ceres group bottom, and emphasizes the need for yield trials to run over several years to even out seasonal effects.

At N. Kinangop, in which a trial has been laid down for the first time this season to find suitable varieties for this newly-opened and important wheat growing area, Cross 362 has shown up well whereas the D.C. x Ceres varieties have yielded poorly. The overall mean yield in this trial is, however, low due to late planting.

WHEAT YIELD TRIAL—OL JORO OROK AND N. KINANGOP

VARIETY	OL JORO OROK		N. KINANGOP	
	*Yield	Position	*Yield	Position
D.C. x Ceres R 46 ..	10·71	1	3·37	10
D.C. x Ceres Control ..	8·43	2	3·03	14
D.C. x Ceres R 64 ..	8·42	3	3·27	11
362.B.1.A.1	7·91	4	4·41	1
362.B.1.A.2	7·65	5	4·03	5
350.AD.9.C.2	7·54	6	3·27	11
362.A.1.D.1	6·95	7	3·13	13
350.AJ.3.A.1	6·89	8	2·84	15
350.AD.9.B.1	6·27	9	3·65	7
362.B.1.E.4	6·15	10	4·07	4
350.AJ.3.A.2 .. }	5·97	11	3·62	8
350.AJ.3.C.1 .. }	5·97	—	3·92	6
362.B.1.A.3	5·78	13	4·37	2
350.AJ.3.C.2	5·58	14	3·41	9
362.B.1.A.4	3·90	15	4·30	3
Mean	6·94	—	3·65	—
Significant differences—				
P.05=	1·08	—	0·86	—
P.01=	1·42	—	1·13	—

*Yield in bags of 200 lb. net per acre.

Baking Quality Tests

Samples of all advanced hybrids and wheats undergoing multiplication for possible release to farmers are sent for baking quality tests to the Nairobi Laboratory of the Kenya Millers, Messrs Unga, Ltd.

Barley

Introductions

The following observations of new introductions were carried out on the Plant Breeding Station at Njoro unless otherwise stated.

1950 *Introductions*

From Plant Breeding Institute, Cambridge.—Earl, which lodged in 1951, stood fairly well this season in the field multiplication plot and looked quite attractive.

From the Department of Agriculture, Victoria, Australia.—The four varieties Cape, Sea of Azov, Vaughn, and Atlas grew well. The first two were more aggressive and looked the heavier yielders.

1951 *Introductions*

From the Swiss Experimental Station for Agriculture, Zürich—Oerlikon.—Adliker 9 grew well and gave grain bushelling 53 lb. Kloster Disentis 29, a naked barley, bushelled 62 lb. Riniker 3 failed to ear due to drought.

From the Ministry of Agriculture, Buenos Aires, Argentine.—Of the 13 varieties mentioned in the 1951 report, 7 were carried on for further trial.

From the Institute for Research on Varieties of Field Crops, Wageningen, Holland.—Mansholt's 2-row, Balder and Agio proved better than Goudgerst. They gave grain of 51 lb., 54 lb. and 54 lb. respectively.

From the Department of Agriculture, Dublin, Eire.—The 25 varieties and crosses, including a number of the newest Scandinavian short-strawed varieties, were promoted from the cage to the small multiplication plots series and will be further studied during the coming season.

1952 *Introductions*

The following introductions were on trial for the first time.

From Dr. R. F. Peterson, Dominion Laboratory of Cereal Breeding, Winnipeg, Manitoba.—Ottawa 3092.A, produced from the Cross Velvet x Olli x O.A.C. 21 and released in 1951. This variety suffered considerable yellowing of the lower leaves and produced small compact kinked heads and small grain.

From the Central Experimental Station, Algeria.—Seven varieties Nos. 42, 2862, 2838, 839, 183, 3270 and 43. All were attacked by stem rust. No. 2838 was the best. The last two will be discarded for poor growth.

From the United States Department of Agriculture, Logan, Utah.—Bonneville C.I. 7248 proved a very vigorous grower with smooth awns and large heads. The grain was disappointing and bushelled only 47 lb.

From the Station Agronomique de L'Alaotra, Madagascar.—Three varieties, Merzaga, Austsirabe and Fahara. All were badly attacked by stem rust and destroyed.

From the Department of Industrial Research, Christchurch, New Zealand.—Three Research selections and F.2 selections from crosses of Kenia x Golden Archer, Spratt Archer and Chevalier, and from Maja x H.H. 12. Some cultures failed to germinate.

From Dr. T. H. Johnston, Agricultural College, Stillwater, Oklahoma.—Harbine C.I. 7524, and Tenkow C.I. 646. They were received too late for fair trial and will be sown again in 1953.

Yield Trials

Yield trials of introductions compared with the standard varieties Prior and Research were laid down at the centres Njoro, 7,100 ft., Ol Joro Orok, 7,800 ft., Eldoret 7,000 ft., and North Kinangop 8,300 ft. The last two represent new trial areas: at Eldoret the aim is to find a barley suitable for the thin lateritic soils of the Uasin-Gishu, and at the latter centre for the cool, high rainfall conditions of the Kinangop Plateau.

Barley Yield Trials—Njoro and Eldoret

Variety	Njoro		Eldoret		Adjusted Njoro Yields	
	Yield*	Position	Yield*	Position	Weighted Mean	Year
Plush	11·85	1	7·79	7	9·05	51–52
Velvon	11·59	2	7·03	11	11·05	51–52
Tregal	11·38	3	8·43	4	8·84	50–52
Ymer	11·28	4	7·62	8	9·48	50–52
Research	10·92	5	9·13	2	9·67	52
Abed Kenia ..	10·46	6	6·69	13	9·21	52
Glacier	10·43	7	8·07	6	9·86	50–52
Hannchen	10·21	8	5·15	16	8·26	50–52
Compana	9·40	9	8·14	5	8·14	50–52
Rex	8·57	10	7·10	10	7·57	51–52
Wisconsin	8·26	11	6·58	14	7·73	51–52
Peatland	7·67	12	9·36	1	6·86	51–52
Sanalta	7·61	13	5·29	15	7·03	50–52
Prior	7·00	14	8·62	3	6·75	50–52
Chevron	6·55	15	7·50	9	6·52	51–52
Mars	6·08	16	6·90	12	6·03	51–52
Mean	8·70		7·46			
Significant differences—						
P.05=	1·41		1·16			
P.01=	1·87		1·55			

*Yield in bags of 180 lb. net per acre.

At Njoro, the American barley Plush heads the list closely followed by the next six varieties, Velvon, Tregal, Ymer, Research, Kenia and Glacier which are all of equal yield at the 5 per cent point. Both Velvon and Plush were easily picked out by eye in the field for their vigorous growth and appearance. Velvon, in particular, has a nice golden colour and short, strong straw; but Plush is probably too tall and may easily lodge in a wet year.

A weighted mean of variety yields at Njoro over the period 1950–52, calculated according to the method given by Patterson (1) is included. Although all varieties do not occur in all three trials, a survey of the adjusted yields shows that

Velvon, Sanalta, Ymer, Kenia, Plush and Tregal are worth extended trials. It is interesting to note that the two short-strawed Scandinavian varieties Kenia and Ymer have given very similar yields.

At Eldoret, Peatland, Research, Tregal and Prior are the highest yielders, being all equal at the 5 per cent point. Velvon, Kenia, and Ymer are all lower in yield (P = .05) than Peatland. In the observation plots of 20 varieties, Velvet, Trebi, Velvon, Tregal, Trabout and Ray proved the most successful.

At Ol Joro Orok and N. Kinangop, Ray, Research and the two Scandinavian varieties have proved of highest yield.

Barley Yield Trials—Ol Joro Orok and N. Kinangop

Variety	Ol Joro Orok		N. Kinangop	
	Yield*	Position	Yield*	Position
Trebi	13·06	1	6·52	6
Ymer	12·00	2	7·52	3
Ray	11·59	3	8·14	1
Prior	11·10	4	6·20	8
Research	10·51	5	7·73	2
Abed Kenia	10·19	6	6·62	4
Vantage	8·44	7	6·53	5
Golden Archer	8·38	8	5·94	9
Spratt Archer	7·43	9	6·52	6
Glacier	6·72	10	4·30	10
Plumage Archer	5·80	11	3·15	12
Newall	4·15	12	3·84	11
Mean	9·12		6·08	
Significant differences—				
P.05=	1·33		0·95	
P.01=	1·75		1·25	

*Yield in bags of 180 lb. net per acre.

This season's trials, taken in conjunction with those of 1952, bring to light the following interesting facts:—

(1) The high yielding ability and adaptability of the Australian variety Research to varying soils and altitudes.

(2) The good yields of the Scandinavian varieties Ymer and Kenia. They have done well in all areas except Eldoret. Although there is no statistical difference in yielding ability between the two (except at N. Kinangop), Ymer has out-yielded Kenia in all four trials by about one bag per acre.

(3) The unsuitability of Glacier to the higher areas on account of yellow ear rust susceptibility.

(4) The success of Ray in the higher areas.

(5) The poor yields of the "classical" varieties Spratt-Archer and Plumage-Archer compared with the remainder.

(6) The potential value of Velvon, Peatland and Tregal at Njoro and Eldoret.

In addition to the yield trial, a number of barleys was under observation at Ol Joro Orok to determine which, if any, might be worth inclusion in a yield trial next season. Of the 20 under test most were severely affected, and some completely destroyed, by yellow rust which attacked both the foliage and the developing grain. Those considered to be worth further trial include Velvon, Compana, Tregal and Peatland.

Barleys Under Multiplication

150 bags of the short-strawed Scandinavian variety Abed Kenia and 20 bags of Ymer were produced and will be distributed for further multiplication during the coming season.

Limited quantities of Peatland and Hannchen were also multiplied during the season but did not offer such promise as Abed Kenia.

Trials at Kitale

In continuation of the trials to find a suitable barley as an alternative crop to maize for the light sandy loams of the Trans Nzoia, a yield trial of eight varieties was laid down on the Kitale Experiment Station. Fertilizer at the rate of 75 lb. per acre of double super-phosphate was drilled with the seed. Yields are very low due to excessive weed growth.

Barley Yield Trial—Kitale

Variety	Yield*
Research	2·7
Hannchen	2·6
Glacier	2·6
Velvon	2·2
Sanalta	2·1
Prior	2·0
Wisconsin	1·5
German	1·3
Mean	2·15

Differences not significant.
*Yield in bags of 180 lb. net per acre.

Although the "F" test showed non-significance it is of interest to note that Research heads the list as was the case in the 1951 yield trial. Glacier, which came third in 1951, retains its place in the present trial and these two barleys would appear worth trial on a field scale.

A barley to be successful in the Trans Nzoia must be a quick and vigorous grower, able to get ahead and smother weed growth which is usually heavy and prolific in this area. It is felt that spraying should be undertaken in conjunction with the trials to determine its effect on growth and yield, or that all future trials should be sprayed as a routine measure to control weeds.

In addition to the yield trial, the 19 American varieties under test last season were again sown in single observation plots. Most were smothered by weeds but Wisconsin again showed up as a potentially useful variety.

On a field scale a 20-acre field of Research barley on a typical Trans Nzoia sand-veld farm near Kitale, drilled, fertilized and managed according to routine

farming practice, yielded some 7 bags per acre. This crop was not sprayed to control weeds but was sown on a relatively clean piece of land and grew away from weeds. This field-scale crop demonstrates that barley can be grown successfully on the light soils of the district and gives encouragement for the future.

Oats

No hybridization work with oats has so far been carried out and the programme aims at testing introduced varieties. A variety, to be successful in Kenya, must be resistant both to stem rust and to crown rust (*Puccinia coronata*). Most introductions, particularly those from Europe, are found to be too susceptible to these diseases to be released for general cultivation. Many are completely destroyed by crown rust. Certain American and Canadian varieties appear to have some resistance to these rusts and work is concentrated on these introductions.

Lampton, from Australia, still remains the standard for hay and feed. Grey Algerian is the recognized milling variety. The latter oat is particularly successful over 7,500 ft. in which areas the plumpest samples are produced.

Introductions

The following introductions were tested on the Plant Breeding Station.

1950 *Introductions*

From U.S.D.A., Beltsville, Maryland.—The five varieties Mohawk, Bannock, Victory, Valor and Fortune have been discarded due to stem and crown rust susceptibility.

From the Department of Agriculture, Melbourne, Australia.—The varieties Mulga, Early Kherson, Early Baart, Palestine, New Zealand Cape, Belar, Guyra, and Orient have been discarded due to rust susceptibility.

From the Dominion Cerealist, Ottawa, Canada.—Of the five varieties introduced in 1950, 3003F (1948) proved the best as was the case last season. It was slightly attacked by stem rust on late tillers and gave grain bushelling 39 lb. Beaver 1948, Garry 1948 and Ajax 1948 were all more severely attacked by stem rust and gave grain of bushel weights 35 lb., 31 lb. and 30 lb., respectively. All remained free from crown rust.

3003F will be further multiplied during the coming season.

1951 *Introductions*

From the Iowa State College, Ames, Iowa.—Clinton, Bonda, Mindo, Benton and Eaton. All remained free from crown rust but the first three suffered stem rust attack with pustules of the R-S to S type. They gave grain of bushel weights 36 lb., 43 lb., 41 lb., 39 lb. and 34 lb. respectively.

From Dr. C. H. Goulden, Dominion Experiment Farm, Ottawa, Canada.—Beaver was severely attacked by stem rust and gave grain of 30 lb. bushel weight.

From the Minnesota Agricultural Experiment Station, Minnesota.—Victoria x (Hajira-Joanette), Mindo x (Hajira-Joanette) x Landhafer, Landhafer x Mindo x (Hajira-Joanette), Andrew, Hajira-Joanette, (Hajira-Joanette) x (Bonda-Rainbow) x Santa Fe, (Hajira-Joanette) x (Bonda-Rainbow). The first four were quite severely attacked by stem rust whilst the remainder were lightly attacked only. Little crown rust attack was observed. The last-named remained free both from stem and crown rust infection.

From the Swiss Experimental Station for Agriculture, Zürich–Oerlikon.—Adliker 9 and Rosegg 2 were both attacked by stem and crown rusts.

1952 *Introductions*

The following introductions were on trial for the first time.

From Dr. R. F. Peterson, Dominion Laboratory of Cereal Breeding, Winnipeg, Canada.—R.L. 2105 (R.L. 1574 x Roxton), R.L. 2123 (R.L. 1574 x Roxton), R.L. 2100 (R.L. 1574 x Ajax) and Canuck (R.L. 811). All except Canuck and R.L. 2100 had slight stem rust infection: in addition, R.L. 2105 was heavily attacked by crown rust but gave grain of 41 lb. bushel weight.

The following five varieties were sown rather too late for a fair test of their performance:—R.L. 127 and 128 (Hajira x Richland), R.L. 524 (Hajira x Banner), Hajira selection R.L. 559.16, and H.566 (Canuck x Victory). All will be carried on to further test in 1953.

From the Central Experiment Station, Algeria.—Palestine 1947, Coura 977, Noire 912, Rouge Nos. 31 and 61. The most promising appeared to be Noire 912. The remainder grew poorly and were attacked by stem rust.

From Cereal Division, Cereal Experimental Farm, Ottawa, Canada.—Lanark (1951), a cross of Onward x (Antony x Bond), grew well and vigorously. It stood well at harvest but suffered considerable attack from stem and crown rust. It gave plump white grain of 43 lb. bushel weight.

From Texas Agricultural Experiment Station, Denton, U.S.A.—Fultex, Fulwin, Mustang, New Nortex and Stanton. These were received too late for a fair test and will be sown again in 1953.

Trials at Ol Joro Orok, Eldoret and Kitale

At Ol Joro Orok a yield trial of the 13 most successful varieties chosen from the 1951 observation plots showed Ajax to have out-yielded the standard variety Lampton ($P<.01$). Achilles and Control secured second and third places respectively. At the lower end of the table the Canadian R.L. oats have not done so well in the drought conditions of the trial.

Oat Variety Trial, Ol Joro Orok

Variety	Yield*
Ajax	7·71
Achilles	6·55
Control	5·25
Lampton	5·19
Boone	4·79
Vichland	3·97
R.L. 1681	3·66
Vikota	3·66
R.L. 1674	3·61
R.L. 1692	3·38
Cedar	3·38
R.L. 1694	2·70
Fultex	2·19
Mean	4·31
Significant differences—	
P.05=	1·41
P.01=	1·85

*Yield in bags of 150 lb. net per acre.

At Eldoret, 18 varieties were studied in observation plots to determine those worth inclusion in a yield trial at a later date. The best proved to be Tama, Control, Vikota, Vichland, Boone and the Canadian varieties R.L. 1674 and 1734.

At Kitale the object with oats is the same as with barley—to find an alternative crop to maize. Thirteen varieties were grown in observation plots and those showing most promise for further trial included Lampton and R.L. 1734 (both of which did reasonably well last season), Vikota and Vichland. The remainder proved less satisfactory and were attacked by rust or were unable to compete with weed growth. Saegar and Yielder were destroyed by rust and set no grain.

Maize

The maize breeding programme is following the aims and objects outlined in the 1950 report. Inbreeding of the various lines continued, including the new collection from African areas in the Colony as well as imported varieties and hybrids. Trials of single and double crosses made in 1951 were carried out and also top crosses of new selected inbreds to test general combining ability. Tests with a hybrid from Southern Rhodesia showed, as expected from past experience, that ready-made hybrids produced elsewhere were unlikely to be successful in Kenya and emphasized the fact that hybrids suited to local conditions must be produced on the spot.

The following is a summary of the main work carried out during the season. The programme allows for the interchange of material between the various centres at which the work is carried out.

Introductions

A double hybrid from Southern Rhodesia, S.R. No. 6, sent by courtesy of the Southern Rhodesia Maize Growers' Association, was tested at 14 different areas in the Colony with 24 farmers. Trials were not statistically planned but took the form of acre plots each of the hybrid and local maize planted in adjacent blocks. The hybrid in all cases matured some 4 to 6 weeks earlier than local maize, was considerably shorter, and had thinner stalks. Cobs were borne lower down relatively on the stems. Shelling percentages were higher than local maize, the figures being 85 per cent and 79 per cent on the average respectively. The introduction was more attacked by leaf blight, *Helminthosporium turcicum*, than local maize.

Regarding yields, except in one instance, local maize out-yielded the Rhodesian hybrid but by a comparatively small margin. Thus, comparative yields on a number of farms were—at Endebess (6,500 ft.) 12.8 and 12.0 bags (200 lb. net) per acre; at Rongai (6,000 ft.) 2.9 and 2.6; at Hoey's Bridge (6,000 ft.) 12.0 and 11.0; at Eldoret (7,000 ft.) 12.9 and 11.5; and at Solai 26.0 and 19.3. At Kipkarren (5,000 ft.) and Nakuru (6,500 ft.) no yield figures were obtained but the farmers carrying out the trials stated that the Rhodesian hybrid gave some 20 per cent to 30 per cent less yield than the local variety. At Sotik (6,000 ft.) only about half the yield of local maize was obtained.

Had it not been for blight attacks, yields of the hybrid in these areas would have been greater. In the higher altitude areas the hybrid was not so successful. Thus at Kipkabus (8,000 ft.), the hybrid yielded only 3.8 bags per acre as against 7.6 for the local variety. The hybrid was here very badly attacked by blight and the foliage destroyed. The one exception referred to was at Karuna (7,000 ft.) where the hybrid yielded at the rate of 10 bags per acre compared with 7.5 for the local yellow variety. In some areas the trial failed due to drought.

Similar trials were carried out at a number of centres with Early Pearl from South Africa. At Kibarani and Matuga, at the Coast, the variety was not impressive and was out-yielded by local maize and by other introductions such as Chester

County, 90 Day and British Honduras. The habit of the Early Pearl was rather spindly and it grew to a height of 5½ ft. compared with the 6½ ft. of the local white variety. Flowering and harvesting took place at Kibarani 48 days and 113 days from planting, compared with 54 days and 122 days respectively for local white. The variety bore one cob per plant, low on the stem. Rust (*Puccinia sorghi*) occurred but not to a significant extent; no *P. polysora* was seen on any of the varieties under test.

At Rongai, 6,000 ft., with a 33 in. rainfall, Early Pearl and local maize yielded at the same rate. The introduction matured earlier and most plants carried two cobs. The shelling percentage of the Early Pearl worked out at 72 per cent compared with 65 per cent in the local variety.

At Kakamega in Nyanza Province, 4,500 ft. with fertile soil and good (70 in. average) rainfall, Early Pearl grew to 4–5 ft. compared with the 8–10 ft. of the local variety. Times to flowering and harvest were 63 and 90 days, and 136 and 199 days respectively. The straw was weak and the introduction, which bore very small cobs, yielded only 9 lb. of grain per plot as against 20 lb. for the local variety.

NJORO

The object is to produce hybrids suited to the higher and cooler maize growing areas of the Colony.

Some 700 inbred lines were under observation, including the original 21 fixed inbreds, which had been split up into 75 sub-lines with the object of testing possible differences. Of the remaining 625 inbreds, 52 S.1's were reduced in the field, and after laboratory examination of the cobs and grain, to 10 lines to be carried on for further study; 152 S.2's were similarly reduced to 38, 110 S.3's to 23 and 37 S.4's to 13. Similarly, the 215 lines in the collection of local Kenya maizes from last season's programme were reduced to 53. The remainder is made up of various miscellaneous material under observation.

Inbreeding of the introductions from the U.S.A., Southern Rhodesia, and South Africa continued, and 51 lines surviving from the 1951 programme were reduced to 18. The Australian hybrids Q.23, Regal N.E.H.18, D.S.28, D.S.30, Standfast G.H.96.A, Victory G.H.134, and Ensign G.H.112.A, which were inbred last season, again grew poorly and were attacked by leaf blight. Promising plants in selected lines were again selfed to give S.2 cobs in an attempt to establish pure, early maturing lines.

In addition, a further number of introductions received from Australia were on trial consisting of—Golden Superb, Funk's Yellow Dent, Hickory King, Leaming, Fitzroy, Wellingrove, and the inbred lines 7, 21, 23, 25, 38-11, 701, 317, WF9, 5120, K4 and Hy2. They arrived rather late for optimum planting conditions but inbreeding was carried out wherever possible.

By courtesy of Dr. E. J. Wellhausen, a collection of maizes was sent from the Rockefeller Foundation in Mexico. It was expected that maize types from Mexico might be more successful in Kenya than varieties from further north in America due to greater similarity of climatic conditions and particularly proximity to the Equator. Dr. Wellhausen, in sending the samples, remarked that their tropical corns in Mexico were found to be rather widely adapted at low elevations between the Tropic of Cancer and the Tropic of Capricorn. The seed, unfortunately, arrived too late for a fair test this season but part was planted for observation purposes. Twelve varieties were received, viz., Vandeno, Comiteco, Zapalote Grande, Olotillo, 1-452 2605-1, 2593-1, 2667-1, 2632, SLP20, Coahuila 8, Capiten, and Amarilla de Cuba. Three of these, Comiteco, Olotillo and 2605-1 proved outstanding for vigour

of growth and freedom from rust (*P. sorghi*) and leaf blight. The others grew more poorly and were attacked to varying degree by these diseases. Inbreeding of the lines commenced with the object of introducing new blood into the breeding programme.

An interesting introduction, on test for the first time, was a maize from the Himalayas in India. This produced small, roundish cobs wiith dark purple, almost black seed. This variety may possibly possess cold tolerance which will make it of value in the production of varieties for growing above the 8,500 ft. mark in the Kenya Highlands. Maize takes too long a period to mature under such conditions and is not generally successful, due to the cold climate with even occasional frosts during the growing period.

91 single crosses, for doubling in 1953, and 330 double crosses for trial next season were made. The double crosses made in 1951 were compared in three triple lattices with 81 varieties in each. A number of common varieties were included for ease of comparison. Of the 240 varieties under test, 18 were shown to have significantly out-yielded the parental Plant Breeding Station mass-selected maize at the 1 per cent level and a further 32 at the 5 per cent level. These will be resynthesized for larger scale trials at a future date. In the single crosses trial, all entries were found to be significantly below the yield of the P.B.S. standard. The top crosses of inbred to parent, using the new inbred lines, showed 18 significantly better than P.B.S. at the 1 per cent level, and a further 29 at the 5 per cent level, out of 55 crosses.

The breeding material produced in Dr. S. C. Harland's Intra-Genotypic method of maize improvement which was started in 1949 was, unfortunately, destroyed by fire.

KITALE

The object is to develop hybrids suited to the Trans Nzoia with its hotter, and wetter climate, and light soils. Resistance to leaf blight (*Helminthosporium turcicum*) is essential in this area.

The programme follows much the same general lines as at Njoro, with further selfing and selection in the various inbred lines and in the introductions from the U.S.A., South Africa, and Southern Rhodesia. The Muratha inbred series were reduced to 15 lines for further study in 1953; similarly 46 S.2's, 40 S.3's and 13 inbred introductions were selected for the coming season. 31 single crosses and 38 double crosses were made.

A serious outbreak of chafer grub, a species of Melolonthid (*Schizonycha* sp.), destroyed a large amount of the breeding material, including the trials of single, double and top crosses. Control was finally effected with Agrocide 3 dug in round the plants.

RONGAI

Due to staff shortages, no maize work was carried out at Rongai during the season. Most of the earlier material was destroyed in the fire and the programme has not yet been restarted.

Sunflowers

The semi-dwarf varieties Mars, Pole Star, and Jupiter, now released from departmental control, are not very satisfactory in that, although suitable for combine harvesting in the lower and hotter areas, they grow too tall for mechanization in the cooler and higher rainfall areas over 7,000 ft.

Accordingly work continued on bulking and selection in the fully dwarf varieties Klein, Southern Cross, Mennonite and Sunrise. The last-named is particularly interesting and at Ol Joro Orok, 7,800 ft., it grew to a height of some 2 ft. only.

A randomized block trial with four replications carried out by the Agricultural Officer at Eldoret gave the following results. At the time this report was written, the figures had not been examined statistically.

SUNFLOWER VARIETY TRIAL—ELDORET

VARIETY	Plant Population per Acre	Time to Harvest	Yield Bags per Acre	Height at Harvest	Oil per cent of Seed
	'000	*Days*	100 *lb.*	*Feet*	
Jupiter	23·1	110	3·67	3–3½	25·1
Pole Star	23·1	84	3·55	3–3½	22·0
Mars	15·6 (1)	86	3·53	3½–4	17·9 (2)
Southern Cross ..	21·9	125	3·19	4	20·4
Klein	23·1	100	2·90	4–4½	28·1
Giant White	3·9 (1)	118	2·24	6½–7	26·5
Giant Black	7·8	125	1·68	6½	24·9
Mean	—	—	2·96	—	—

(1) Poor seed. Low yields due to drought and bird damage.
(2) Seeds not fully formed.

Spacings used were: (1) for the Giant varieties 3 ft. between rows and plants 1 ft. in the row; (2) for the Dwarf varieties 1½ ft. and 8 in. respectively. A heavy seed rate was used and plots were subsequently thinned to give the correct stand. The trial was given a basal dressing of 120 lb. double superphosphate per acre.

In the absence of statistical examination, any critical assessment of the results is impossible. Nevertheless, it is interesting to note that this trial bears out the conclusions arrived at in earlier work that the Dwarf sunflowers are capable of yielding as highly as the Giant varieties provided they are spaced more closely to compensate for their smaller individual size and yield. They also possess the advantage of considerbly earlier maturity.

Sorghum

The programme as originally planned aimed at the improvement of local varieties for African use and the production of dwarf types, suitable for combining, for use in European farming areas. European farmers have, however, shown little interest in sorghums, possbly because maize can usually be grown satisfactorily in most areas, and the work has accordingly centred on the first objective. To this end the building up and testing of a collection both of local varieties and introductions was continued during the present season.

At Machakos (5,000 ft.) 26 local selections and 54 introductions were under test in observation plots. Those showing most promise either for grain or fodder were selected for further trial. A trial in the long rains of American dwarfs against a local standard variety showed Black Kafir to be significantly better than the standard Mataliko. There were no differences between the dwarf varieties. A short rains trial of the same varieties and local standard proved non-significant.

Experimental Work

WHEAT RATE OF SEEDING TRIALS

These trials continued for a further season. They follow normal farming practice and are laid down in randomized blocks, 1/5th-acre each, with four replications. The trial at Rongai was abandoned due to a harvesting mistake.

This season's results are:—

Njoro (7,100 ft.)				Ainabkoi (8,000 ft.)		Moiben (6.000 ft.)	
360.H		294.M		1066		294.M	
SR	Yld.	SR	Yld.	SR	Yld.	SR	Yld.
135	7·1	115	8·2	130	4·3	150	10·2
119	7·0	71	8·2	110	4·2	90	10·1
90	6·8	120	8·1	150	4·1	130	10·1
65	6·6	79	7·9	90	3·6	110	10·0
91	6·4	39	7·9	70	3·2	30	9·9
44	6·2	60	7·8	50	2·7	50	9·8
33	5·5	31	6·8	30	2·2	70	9·6
Mean ..	6·51		7·84		3·49		9·96
Significant differences—							
P.05 = 0·6			0·5		0·45		Not
P.01 = 0·8			0·65		0·6		Sig.

SR=Seeding Rate used.
Yield given in bags of 200 lb. net per acre.
Fertilizer used: Njoro—none.
Ainabkoi—200 lb. Double Superphosphate per acre.
Moiben—130 lb. Double Superphosphate per acre.

At Njoro, with 360.H, there is, with one exception, a gradual and progressive drop in yield with decreasing seed rates. There are no significant differences between rates of 65 lb. and over. The results with 294.M are not so regular but the lowest rate used, 31 lb. per acre, is significantly poorer ($P<.01$) than the remainder. There are no significant differences between the remainder.

At Ainabkoi 100 lb. and over have given higher yields than rates below this figure. Rate below 70 lb. caused a rapid reduction in yield.

At Moiben, no significant differences between seeding rates could be demonstrated. There is a suggestion, however, that rates of 90 lb. and above have tended to yield more heavily than lower rates.

At Moiben, no significant differences between seeding rates could be demonstrated. There is a suggestion, however, that rates of 90 lb. and above have tended to yield more heavily than lower rates.

Three years' experiments have now been concluded at most centres. A preliminary survey by Mr. P. Robinson, Statistician to the East African Agriculture and Forestry Research Organization, suggests that the maximum yield will be obtained on the average with a seeding rate of about 90 lb. per acre.

It is hoped to publish full results elsewhere at a later date.

Barley Fertilizer Trials

This trial, laid down at the three centres Njoro, Molo and Ol Joro Orok last season with the object of testing the effect of nitrogen, phosphorus and potash on yield and malting quality in barley, was sown at the single centre Ol Joro Orok during the present season. Yield figures only were recorded. Full details of the lay-out, plot size and treatments were given in the 1951 Annual Report. The variety used was again Research.

Results

The analysis of variance table is appended, from which it is seen that the application of superphosphate has produced highly significant results. This is in line with the 1951 results.

In addition, both muriate of potash and sulphate of ammonia, and the interaction PN, are all highly significant. Neither of these two main treatments, nor the PN interaction, reached the level of significance last season.

Analysis of Variance

Variation due to	d.f.	Mean Square	"F"
Blocks	5		
P	2	2·4491	122·46*
K	2	0·2349	11·75*
N	2	0·5786	28·93*
PK	4		
PN	4	0·1947	9·74*
KN	4		
NPK (unconfounded)	4	0·1173	5·87*
NPK (partially confounded)	4	0·5059	25·30*
Error	22	0·0200	
Total	53		

*Significant at P=·01.

Yields of Main Treatments

P0	2·81	K0	3·83	N0	3·52
P1	4·02	K1	3·63	N1	3·99
P2	4·02	K2	3·40	N2	3·34

Significant differences—
P.05=0·18.
P.01=0·25.

Bags of 180 lb. net per acre.

Interaction PN

It is seen that the effect of superphosphate is greater in the presence of sulphate of ammonia than in its absence. This positive interaction is significant (P<.05) at the lower rate of application only. The higher rate fails to reach significance.

	N0	N1	N2	Mean
P0	3·00	3·25	2·67	2·97
P1	3·73	4·73	4·29	4·25
P2	4·44	4·69	3·63	4·25
Mean	3·73	4·22	3·53	3·82

Significant differences—

Means	P.05=0·18	P.01=0·25
Single Treatments	P.05=0·31	P.01=0·43

Mean Response to Superphosphate (112½ lb. per Acre)

Sulphate of Ammonia	Bags per Acre	Difference
(*i*) Absent	+1·08	
(*ii*) 25 lb. per acre ..	+1·46	+0·38*
(*iii*) 50 lb. per acre ..	+1·29	−0·17

*Significant at P=·05.

Conclusions

(1) Application of double superphosphate at 75 lb. per acre significantly ($P < .01$) increased yield. A second application of a similar amount led to no further increase.

(2) Application of muriate of potash at 25 lb. per acre significantly ($P < .05$) decreased yield. A second application of a similar amount led to a further significant ($P < .05$) decrease in yield.

(3) Application of sulphate of ammonia at 25 lb. per acre significantly ($P < .01$) increased yield. A second application of a similar amount led to a significant ($P < .01$) reduction in yield.

(4) There is a significant positive interaction ($P < .05$) between superphosphate and sulphate of ammonia at the lower level of application.

NPK interactions are significant; remaining interactions are non-significant.

Publications

(1) "Food Production and Plant Breeding", an address delivered before the Nairobi Scientific and Philosophical Society, and published in their Annals and also in the local Press.

(2) "The 1952 Seed Maize Competition" in the *K.I.O. Fortnightly* No. 144 of 7/2/53, and in the local Press.

(3) "A Note on the Release of Some New Cereal Varieties—IV" in the *East African Agricultural Journal,* Vol. XVIII, No. 3, of January, 1953; in the *K.I.O. Fortnightly,* No. 244 of 7/2/53; and in the local Press.

(4) "Cereals for 1953-54" in the *K.I.O. Fortnightly,* No. 245 of 21/2/53, and in the local Press.

Reference

(1) Patterson, R. F., *Agronomy Journal,* 42, p. 509, 1950.

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H. C. THORPE,
Senior Plant Breeder.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, KITALE, 1952

Meteorological Information

The following shows the year's records, measured at the Soil Conservation Service Office, and on the Grassland Research Station Farm, some 2 miles south.

Month	S.C.S. Office	G.R.S. Farm
	inches	*inches*
January	Nil	Nil
February	0·19	0·20
March	4·66	4·69
April	7·70	7·53
May	10·95	7·25
June	2·67	2·85
July	3·54	2·92
August	8·27	6·91
September ..	2·15	2·45
October	4·77	4·52
November ..	1·29	1·33
December ..	0·17	0·05
Total ..	46·36	40·70

Rainfall was heavy during April and May, followed by prolonged dry spells in June and July, which increased difficulties of ley establishment, especially for vegetative propagation. Dry weather set in early at the end of the season, and this caused further difficulty for the later plantings. On the whole, the season has been a difficult one.

Experimental Work

A.—On the Grassland Research Station, Kitale

The following is a brief summary of the work carried out on the Grassland Research Station during the year.

(1) *Plant Introduction*

During the season, some 540 grasses and legumes were sown in the two nurseries. This brings the total planted since the nurseries were started in 1951 to 1,190. The grasses which appear most important for the Kitale region (tall grass, low tree ecological zone) are:—

Rhodes grass (*Chloris gayana*).
Molasses grass (*Melinis minutiflora*).
Star grass (*Cynodon dactylon*).
Guinea grass (*Panicum maximum*).
Setaria sphacelata.
Cenchrus ciliaris.
Elephant grass (*Pennisetum purpureum*).

Special collections of these are being made.

The legumes which have shown most promise are:—

Vigorous creeping vines—
Glycine javanica.
Dolichis falcatus.
Vigna schimperi.
Dolichos sp. ex Kilima Kiu.

Forms more suitable for general purpose leys—
Alysicarpus glumaceus.
Stylosanthes gracilis.
Teramnus repens.
Trifolium semipilosum.

Annuals—
Trifolium subrotundum.
Trifolium alexandrinum.

Many of the plots were clipped whenever they were judged to have reached grazing or silage stage. Although not statistically significant, the order of vigour for the periodic cuts of the grasses is of interest. These were:—

1st.—Three *Hyparrhenia* spp.
2nd.—*Setaria sphacelata* ex Nandi.
3rd.—*Urochloa bulbodes.*
4th.—Two *Panicum maximum* vars.
5th.—Three *Panicum maximum* vars. and *Pennisetum glabrum.*
6th.—*Cenchrus ciliaris, Brachiaria brizantha, Brachiaria soluta,* and others.
7th.—*Beckeropsis uniseta* and others.
8th.—*Melinis maitlandii, Paspalum dilatatum, Chloris gayana, Bothriochloa insculpta* and others.

N.B.—These cuts were done on single plots in the nursery.

(2) *Field Muntiplication of Seed and Planting Material*

Multiplication plots of the following grasses and legumes were established:—

Hyparrhenia lintonii.
Clitoria ternatea.
Indigofera retroflexa.
Setaria splendida.
Hyparrhenia sp. near *hirta.*
Glycine javanica.
Cenchrus ciliaris (erect form).
Panicum maximum var. *trichoglume.*
Dolichos sp. near *lablab.*

Seed yields, viability, etc. were recorded.

(3) *Evaluation of natural grassland.* (H.O. No. 13B/11)

The object of this experiment was to study variations in the composition of natural grassland at different seasons, and to obtain an estimate of its productivity. Results showed that seasonal variations could not be assessed by the methods used, and the experiment is therefore to be abandoned. The average yield of green material cut at "grazing stage" during the whole season was 2½ tons per acre.

(4) *The establishment of a temporary ley under barley.* (H.O. No. 13D/33)

The object of this experiment was to study methods, applicable to the wheat-producing areas, of establishing temporary leys. An attempt was made to establish

a Rhodes grass and *Alysicarpus glumaceus* mixture under barley at two different spacings, and to compare growth made with and without a "nurse" crop. The experiment was ruined by failure of the barley and intense weed competition.

(5) *Evaluation of herbage spp.* (H.O. No. 13C/12)

Sixteen grass species were planted in small plots, with four replicates. Cuts were taken (1 sq. yd. per plot) starting at the beginning of the rains.

The grasses are arranged here in descending order according to their average yield, expressed in tons per acre for the season. The highest gave 13.8 tons per acre of green material and the lowest 5.1 tons per acre.

Panicum maximum. (ex Kitale.)
Melinis minutiflora. (Chania strain.)
Brachiaria soluta.
Hyparrhenia filipendula.
Setaria trinervia.
Brachiaria brizantha.
Panicum maximum var. *trichoglume.*
Melinis minutiflora. (Commercial.)
Themeda triandra.
Chloris gayana.
Panicum coloratum var. *makarikariensis.*
Setaria sphacelata. (ex Nandi.)
Cenchrus ciliaris. (Prostrate type.)

N.B.—This list is given to show the general trend, pending statistical analysis of the yield figures.

(6) *Establishment of temporary leys.* (H.O. No. 13D/28)

The object of this experiment was to examine the relative merits of three methods of establishing grass leys.

The three methods of establishment were:—

(*a*) Direct seeding or planting.

(*b*) Seeding or planting under oats.

(*c*) Seeding or planting under maize.

Two grasses were used:—

(*a*) Molasses grass. Seed sown.

(*b*) Star grass. Local *Cyndon dactylon.* Roots planted.

Two fertilizer treatments were used:—

(*a*) Nil.

(*b*) 60 lb. P_2O_5 + 100 lb. N. broadcast after establishment of the grass.

There were four replicates.

Pending statistical analysis of the figures, the following observations are given.

(*a*) The cost of planting star grass roots was only about one-third the cost of sowing molasses grass.

(*b*) The fertilizers appear to have had a significant effect on growth and subsequent yield of the grasses. This is especially marked in the case of the star grass which evidently demands a high fertility level before it will thrive under these conditions.

(*c*) The leys established under maize are approximately equal to those established by the other two methods.

(*d*) No benefit was derived from having an oat companion crop. This may, however, have been due to the management. Grazing of the oats was left rather late.

(*e*) The molasses grass has outyielded the star grass.

This experiment is to be kept under observation in 1953, but no further sampling will be done.

(7) *Plant selection—Legumes and Grasses*

Selection of *Alysicarpus glumaceus* forms was started.

Seven plants of each of the following groups were dug from a field:—

A. Prostrate, narrow leaved form.

B. Prostrate, broad leaved form.

C. Decumbent or semi-erect form.

D. Semi-erect form with tall flowering stems. (Only four plants dug.)

All were chosen for density and leafiness. Six splits of each plant were established in lines.

Selection of *Setaria sphacelata* (ex Nandi) was started. Six leafy clones were chosen. Selection of *Setaria splendida* has resulted in four leafy clones, differing in form from a lax type to a very erect type.

(8) *The fertilizing of natural grassland.* (H.O. No. 13E/2)

This is a factorial experiment, comparing five levels of N and two of P. Cuts were taken during the season, and figures so far indicate that:—

(*a*) Ammonium sulphate has had a depressing effect on soil pH, while superphosphate has had no adverse effect.

(*b*) The composition of the sward is changing. *Cyperus* spp., *Digitaria scalarum,* and *Setaria trinervia* are increasing presumably due to the N, while the increase in *Cyperus* spp. may also be due to P. The original sward was dominantly *Loudetia kagarensis.*

(*c*) There is no significant response to P. There is some interaction between N and P at the higher levels. There is a significant response to N.

(*d*) The yield increases obtained are such as to make fertilizing of permanent grassland quite uneconomic at present prices.

(9) *The effect of fertilizers on establishment and seed yield of Alysicarpus glumaceus.* (H.O. No. 13E/1)

Figures await final analysis, but yields indicate little or no response to fertilizers in establishment or seed production. Perhaps this is due to a deficiency or limiting factor of some kind.

(10) *The fertilizing of molasses grass for seed production.* (H.O. No. 13E/2)

The main object has been to study the effect of levels of N and P on seed production. Final analysis of the figures remains to be done. Indications are that P has no effect on seed yield, while N has given a marked yield increase. There is some interaction between N and P at the higher levels.

(11) *The cultivation and surface seeding of natural grassland.* (H.O. No. 13B/5)

A number of grasses and legumes were sown on the surface of the natural grassland (dominated by *Loudetia kagerensis*) with and without surface cultivation, and with and without fertilizer.

Results so far show that without thorough cultivation to kill much of the existing herbage, surface seeding is likely to be of little value. Fertilizing has had no appreciable effect on the establishment of the seedlings, but did increase their growth, especially on the N.P. plots.

Of the grasses, the best establishment was obtained from *Melinis minutiflora* and *Setaria sphacelata* (ex Nandi) while *Stylosanthes gracilis* and *Alysicarpus glumaceus* were the best in this respect among the legumes. Cultivation alone appeared to effect no improvement on the growth and composition of the sward.

(12) *The establishing of temporary leys by means of a maize planter, at the same time as the maize.* (H.O. Nos. 13D/31 and 13D/32)

The objects of these trials were:—

(*a*) To examine the possibilities of establishing Molasses and Rhodes grass under maize by means of a maize planter, using certain adaptations.

(*b*) To compare these grasses, established at the same time as the maize, with leys established by the normal method of broadcasting after the last hand cleaning.

(*c*) To compare leys planted with and without a legume (*Alysicarpus glumaceus*) in mixture.

(*d*) To compare the effect of the two establishment methods on the yield of maize.

Both Rhodes grass and molasses grass were sown in simple observation trials.

Results have shown that:—

(*a*) Both grasses can be established satisfactorily under maize by means of a maize planter. On both leys the rows have failed to fill in, leaving room for weeds.

(*b*) At the first grazing the leys drilled at the same time as the maize outyielded those broadcast later: subsequently there was little or no difference.

(*c*) The legume appears to have made no difference, either to the growth of the grass or to the total yield of the herbage.

(*d*) The yield of maize was reduced by approximately one-third in both cases where the ley was drilled at the same time as the maize.

The trials have shown that this method of establishment has little to recommend it to the farmer, especially in view of the adverse effect of the grass on maize yields. For the time being, therefore, farmers should be advised to continue ley establishment by sowing seed in maize after the last hand cleaning.

(13) *Miscellaneous trial leys.* (H.O. No. 13C/1(*c*))

During the season, the following one acre ley mixtures were established:—

(*a*) *Panicum maximum*	10 lb. per acre
Brachiaria brizantha	10 lb. per acre
Alysicarpus glumaceus	4 lb. per acre
(*b*) *Chloris gayana*	5 lb. per acre
Setaria sphacelata (ex Nandi)	10 lb. per acre
Stylosanthes gracilis	4 lb. per acre
Dolichos falcatus	2 lb. per acre
(*c*) *Melinis minutiflora*	10 lb. per acre
Brachiaria brizantha	10 lb. per acre
Lucerne	5 lb. per acre
Alysicarpus glumaceus	2 lb. per acre

These were established by drilling down every second spout of an I.H.C. combine corn drill. The seed was sown in mixture with fertilizer.

The leys were grazed together several times during the season, and are to be subjected to a simple management trial in 1953. In each case there was a satisfactory establishment.

(14) *The utilization and management of elephant grass.* (H.O. No. 13C/23)

Plots were established, with and without a legume in mixture, and at spacings of 3 ft. and 7 feet. These were grazed twice during the season and are to be used for observations on management during 1953.

(15) *The eradication of thorn bush.* (H.O. No. 13B/6/2)

Groups of *Acacia* spp. were treated with the following:—

2 chemicals: 2, 4-D and 2, 4-D + 2, 4, 5-T.

2 concentrations: 1:20 and 1:5.

2 carriers: diesel oil and water.

4 methods of application—

Painting on to a ring bark cut.
Applied to top of cut stump only.
Applied to complete stump.
Applied to split stump.

Final counts will be made in 1953. Indications are:—

(*a*) 2, 4-D alone in water at both concentrations is ineffective.

(*b*) 2, 4-D alone is effective only when used at the higher concentration in mixture with diesel oil, and painted on to split stumps.

(*c*) 2, 4-D + 2, 4, 5-T in water, appears to be effective at both concentrations.

(*d*) The highest percentage kill seems to be where stumps are split prior to application of the chemical.

(*e*) The mixture of the two substances in diesel oil is, apparently, the most reliable.

(16) *Preliminary ley mixture trial.* (H.O. No. 13C/1(*b*))

The object of this trial was to make a preliminary study of all promising grasses and legumes in simple mixtures, under grazing conditions. This is regarded as the next step after the nursery introduction stage. The grasses were sown in small duplicate plots, crossed with *Alysicarpus glumaceus, Stylosanthes gracilis,* and lucerne. The legumes were sown in similar sized plots, crossed by separate strips of Rhodes and molasses grass. All plots have been grazed uniformly since establishment.

The following grasses have been outstanding so far, and appear comparable with Rhodes and molasses:—

Setaria sphacelata (ex Nandi).
Setaria splendida.
Pennisetum trachyphyllum.
Sporobolus filipes.
Paspalum dilatatum.
Cynodon dactylon (intermediate form).
Panicum maximum.
Panicum maximum var. *trichoglume.*
Hyparrhenia cymbaria.
Beckeropsis uniseta.

The legumes generally have made disappointing growth so far. The following have been most successful:—

Dolichos falcatus.
Glycine javanica.
Stylosanthes gracilis.
Alysicarpus glumaceus.
Trifolium cheranganiense.

Lucerne germinated well but has made little growth and has been a poor producer. Observations will continue in 1953.

(17) *Ecological study; the effect of fire on natural grassland.* (H.O. No. 13B/12)

An area of typical grassland has been protected from fire since 1950. An adjoining area has been burned annually since then, and will continue to be burned each year. Quadrats have been fixed, and changes in composition of the vegetation will be recorded.

(18) *The effect of levels of N and P on establishment and productivity of a ley.* (H.O. No. 13E/5 (modified))

Two levels of N and two of P were used in the seed bed for establishment of a Rhodes grass: *Alysicarpus glumaceus*: *Stylosanthes gracilis*: Lucerne mixture. The P plots were split for comparison of one complete application v. 3 smaller applications during the season. For some reason which is not quite clear, establishment of grass was poor on all the plots. There was, however, a definite response to fertilizer. Response to either N or P alone was poor, but there was an interaction between the two. This experiment is a failure and will be discontinued.

B.—Co-operative Experiments

During the season Mr. G. Roberts supervised trials and experiments at the following places:—

Site A.—Ainabkhoi, 8,500 *feet*

(1) *Experiment to ascertain the effect of N and P on establishment of a ley*

A mixture of Cocksfoot and Lucerne was used. From observation, it appears that the main effect is from P. Sulphate of ammonia has had the effect of encouraging growth of Kikuyu grass. Establishment was not sufficiently advanced to allow a cut. There does not seem to be any marked interaction between N and P. This experiment is to be continued.

(2) *Single species observation plots*

A large number of grasses and legumes were sown. The most promising grasses are:—

Cocksfoot.
Setaria sphacelata (ex Nandi).
Beckeropsis uniseta.
Paspalum dilatatum.
Hyparrhenia sp. nr. *hirta.*
Melinis minutiflora.
Brachiaria brizantha.

The most promising legumes are:—

Trifolium semipilosum.
Trifolium cheranganiensis.
Serradella.
Trifolium pratense.
Crotalaria intermedia.
Alysicarpus glumaceus.

(3) *A simple grazing trial set out in "grid" form*

Of the species sown, only Serradella and *Setaria sphacelata* succeeded.

Site B.—Ainabkhoi, Altitude 8,500 *feet*

(1) *An experiment to determine the effect of fertilizer on establishment and growth of Kentucky Fescue*

This experiment, sown in 1951 was never cut. Plots were grazed in 1952 when growth was sufficient. The grass proved most unpalatable and unattractive. There was a marked response to P, while N had no apparent effect on establishment. The experiment is to be discontinued.

Site C.—Kipkabus, altitude 8,000 *ft. (grey/brown soil)*

(1) *The fertilizing of permanent Kikuyu grass pasture*

This experiment was started in 1950. Fertilizers were applied in 1952, but no cuts taken. Plots were grazed. To be continued with full recording of cuts in 1953.

(2) *Simple grazing trial laid out in "grid" form*

There was some germination but, due largely to adverse weather and soil conditions, the grasses all failed by the end of the season.

Site D.—Kipkabus, altitude 8,000 *ft. (grey/brown soil)*

(1) *The effect of levels of N and P on establishment and productivity of a ley.*

(2) *Simple grazing trial laid out in "grid" form*

(3) *Grass/legume observation plots*

Soil conditions on this farm are almost identical with those at Site C. Due to some reasons which are not fully understood the experiments have been a failure. Work on this type of land is to be continued in 1953, when the emphasis will be on techniques for ley establishment.

Eldoret Experiment Station, altitude 7,000 *feet*

(1) *The effect of levels of N and P on establishment and productivity of a ley*

Setaria sphacelata (ex Nandi) was sown in mixture with lucerne. Growth was insufficient to enable a cut to be made before the end of the season, but the indication is that P alone has produced no visible beneficial effect. In fact, the pure P plots tended to "burn" during the dry season, more than other treatments. N alone gave a marked increase in growth, and there is a distinct interaction between N and P. Lucerne has made disappointing growth and has practically disappeared from most plots. To be continued in 1953.

(2) *Observation plots of single grass and legume spp.*

Among the grasses which show most promise are:—

Paspalum dilatatum.
Molasses grass.
Setaria sphacelata (ex Nandi).
Brachiaria brizantha.
Panicum maximum (K.51286 ex Sigor).
Pennisetum trachyphyllum.

Outstanding legumes are:—

Vigna schimperi.
Alysicarpus glumaceus.
Vigna gracilis.
Trifolium cheranganiensis.
Trifolium semipilosum (occurs naturally in the locality).
Tephrosia holstii.
Dolichos falcatus.
Serradella.
Crotalaria intermedia.
Astragalus venosus.

(3) *Fodder grass trial*

Of the grasses which may be used for special "fodder" leys, the following have given a good performance so far in single observation plots:—

Elephant grass.
Kazungulu *Setaria.*

Site E.—Kipkabus, altitude 8,000 *ft. (red soil)*

(1) *The effect of N and P on establishment and productivity of Rhodes grass*

Established under oats in 1951. The experiment was refertilized in 1952 but no cuts were recorded. Plots were grazed.

(2) *Single observation plots of grass and legume spp.*

Leys can be established more easily, and appear to make better growth in this red soil, than in the grey/brown soil of the farm which adjoins.

Grasses which made successful growth are:—

Rhodes grass.
Molasses grass.
Brachiaria brizantha.
Pennisetum trachyphyllum.
Beckeropsis uniseta.
Panicum maximum.
Paspalum dilatatum.
Paspalum scrobiculatum.

A number of legumes made good growth, including:—

Trifolium cheranganiensis.
Trifolium semipilosum (grows naturally in the area).
Vigna gracilis.
Alysicarpus glumaceus.
Stylosanthes gracilis.

There is evidence to show that at these altitudes, establishment technique and early management, including *time* of applying fertilizer, are of special importance. 1953 trials will aim at studying some of these factors.

Site F.—Moiben Valley, altitude 6,500 *feet*

(1) *Grass/legume single observation plots*

The following grasses made outstanding growth:—

Rhodes grass (flourishes naturally in the area).
Setaria sphacelata (ex Nandi).
Hyparrhenia sp. nr. *hirta.*
Panicum maximum (ex Sigor).
Molasses grass.
Beckeropsis uniseta.

The following legumes were outstanding:—

Lucerne.
Dolichos lablab.
Vigna gracilis.
Dolichos sp. nr. *lablab.*
Vigna schimperi.
Dolichos falcatus.
Alysicarpus glumaceus.
Tephrosia holstii.
Vigna oblongifolia.
Crotalaria intermedia.

The Moiben Valley is undoubtedly a fine mixed farming area, capable of supporting highly productive leys. This is one of the few areas in which lucerne appears to grow vigorously in the field without irrigation.

Site G.—Lugari, altitude 5,500 *feet*

(1) *Grass/legume, single observation plots*

In this area, which is excellent for livestock, the following grasses are outstanding:—

Star grass (*Cynodon dactylon*).
Panicum maximum.
Molasses grass.
Cenchrus ciliaris.
Brachiaria brizantha.
Setaria sphacelata (ex Nandi).
Beckeropsis uniseta.
Paspalum dilatatum

The following legumes appear to make excellent growth:—

Lucerne.
Dolichos lablab.
Crotalaria intermedia.
Centrosema pubescens.
Stylosanthes gracilis.
Dolichos falcatus.

and many of the vigorous creeping types.

Site H.—Cherangani, 6,000 feet

There are two experiments in progress on this farm, designed to investigate the eradication of thorn bush by chemical means. The chemicals are hormone substances 2, 4-D, and a mixture of 2, 4-D and 2, 4, 5-T. The final results from these experiments will be available in 1953. First observations are very encouraging.

Site I.—Kitale, altitude 6,000 feet

Single plots of grasses and legumes were established in an area which is subject to seasonal waterlogging, i.e. a "vlei" or seasonal swamp. The following grasses made excellent growth:—

Paspalum dilatatum.

Beckeropsis uniseta.

Setaria sphacelata (Kazungulu).

Setaria sphacelata (ex Nandi).

The legumes did not flourish as well as the grasses, but the following have possibilities for this type of land:—

Subterranean clover.

Vigna gracilis.

Glycine javanica.

Stylosanthes gracilis.

It appears that thorough cultivation will be an essential for the successful establishment of productive grass on these areas. Work here is to continue in 1953, and some attention will be paid to management, which is particularly difficult during the rainy season when the ground is swampy and grazing impossible.

Acknowledgments

Special thanks are due to Dr. William Davies of the Grassland Research Station, Stratford-on-Avon, for his kindness in seconding Mr. J. O. Green to Kenya during the year. Much benefit has been derived from Mr. Green's experience and advice, and the Pasture Research Team wishes to express its gratitude to him for his work in this country.

R. STRANGE,
Pasture Research Officer.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, SCOTT AGRICULTURAL LABORATORIES, NAIROBI, 1952

A report on Kisokon grazing and bush-clearing trials (Kamasia Reserve) was prepared by the Pasture Research Officer stationed at Nairobi (A.V. Bogdan). The report was read and discussed at a meeting of the Pasture Research Team in July, 1952. The trials have shown that goat grazing, periodical fire and mowing kept thorn bush (*Acacias*) suppressed while cattle grazing encouraged its regeneration. The results of the trial indicate also that wet season grazing by cattle, being less selective, produced finally better herbage than highly selective dry season grazing. Although the goats were mostly browsing and did not consume the grass to any considerable extent, they produced, by trampling, more destructive effects on the grass cover than cattle, even under higher density of cattle grazing.

Publications

A. V. Bogdan.—"Observations on Stoloniferous Grasses in Kenya." *Journal of the East Africa Natural History Society,* Vol. XX, No. 2, December, 1952. Nairobi. Pp. 71–76.

A. BOGDAN,
Pasture Research Officer.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, MOLO, 1952

Rainfall

Month	1952
	inches
January	—
February	—
March	0·99
April	7·07
May	10·34
June	2·15
July	6·84
August	8·74
September	5·21
October	3·36
November	1·84
December	0·45
Total ..	46 99

No records taken for January or February, 1952.

Altitude: 9,000 ft. approximately.

Experimental Work

Owing to lack of funds and stock, and the generally undeveloped state of the station at the beginning of 1952, experimental work was restricted to trials and experiments which did not need to be grazed. These plot trials were further hampered by the extremely dense weed infestation on the old arable land.

Nursery Work

Small plots of 268 different grasses and 99 legumes were sown for observation on old arable land of low fertility. The majority of species came from lower altitudes and either did not germinate at all or were so slow that establishment was poor because of weed competition.

Grasses

It is of interest to note that of the main herbage genera of the middle altitudes (5,000 ft. to 8,000 ft.) i.e. *Brachiaria, Chloris, Panicum, Cynodon* and *Setaria,* only the *Setaria* group showed any promise; germination of the other groups was in most cases nil, and even when planted from splits results were poor.

The "Nandi" strain of *Setaria sphacelata* germinated well, but is slower to establish than Cocksfoot; even so, this and some of the other *Setarias* established from splits, grew better in the dry season than exotic species, and they may well be found useful for special dry season grazing or as permanent pastures. One

strain of *Cynodon dactylon* (ex Kakamega) established well from splits and more intensive trials are warranted; it is probable that the Ol Joro Orok strain of star grass will establish well in this area.

It is too early to draw any conclusions for the exotic temperate grasses which were sown, but the following points are of interest:—

A.—Rate of Growth

Short Rotation Ryegrasses

Wimmera, and Westernwolths Ryegrass.—These short-term grasses are very quick growers and produce a good yield of herbage within 2 months of sowing. Shooting starts 3 and 4 months afer sowing with *Wimmera* and *Westernwolths* respectively. As soon as this starts the leaves die off (particularly with *Wimmera*) and stemmy material remains. These grasses produce abundant seed and should be used with caution as it is likely that the spread of ryegrass into arable fields is due in part to them (particularly *Wimmera*).

Italian ryegrasses and New Zealand H.1 ryegrass.—These short-term ryegrasses produce a good yield of herbage within 2½ to 3 months of sowing and recover well after cutting. NZ. H.1 ryegrass was the only one to shoot 5½ months from sowing and approximately 50 per cent of the plants were in flower 6½ months from sowing; diverse types are present in this strain and the seed yield is likely to be heavy.

Perennial Ryegrasses

These produce a good yield of herbage 3 to 4 months after sowing. New Zealand certified mother seed, S101, and Irish Perennial after 3 months, S23 and S24 after 4 months.

Flowering has been very poor; no flowers have appeared to date (9th January, 1953), on S23, S24 and S101, but 5 per cent of the New Zealand plants were in flower and 10 per cent of the Irish Perennial; variation between plant types is marked in the latter.

At the time of writing these grasses do not seem to withstand the dry season well.

Meadow Fescues

The S215 and S53 strains gave a fair yield of herbage 4 months after sowing (not as good as the previous species). Both strains were 100 per cent infected with rust and unless this is overcome, their use seems problematical.

Tall Fescues

These (NZ. Tall, S53 tall, K31) produced a fair yield of herbage 4 months after sowing. K31 appears to seed well while only 5 per cent to 10 per cent of the plants of the other strains flowered.

All have withstood the dry season well to date, and remain green.

Cocksfoot

Late sown Cocksfoot (sown 25th July, 1952); after 5 months S37, Akaroa, S26, and S143 were just grazable with 3 to 4 in. of leaf, no flowering being observed. Danish Cocksfoot 5 per cent in flower, and more advanced than the others.

Early sown Cocksfoot (sown 21st April, 1952); Pasture/Hay type (S26) produced a fair amount of herbage 4 months after sowing. The Commercial, Akaroa, S37 and S126 did not produce to the same extent until 5 months after sowing.

Flowering was poor on all except the Commercial and Pasture/Hay types which were in full flower by January, 1953.

In general the Cocksfoot produced a poor amount of herbage in the first 6 months; all seem to feel the dry weather and do not grow during that time.

These exotic grasses were sown on low fertility land fertilized with 4 cwt. Single Superphosphate, 2 cwt. Muriate of Potash and 4 cwt. Nitrate of Soda per acre, broadcast; duplicate plots sown with no fertilizers were at least six weeks behind them in growth, and growth was generally poor, except for the short-term Rye grasses which produce well for a short while on land of low fertility.

Legumes

With the exception of some of the indigenous clovers, legumes from lower altitudes do not appear to grow well; out of 74 legumes sown, 25 only were established and no promising material was seen.

The selection of indigenous clovers for the high altitude areas may well yield promising results.

B.—Fertilizer Experiment

A Lucerne N.P.K. lime experiment (4) was sown late, on 19th August, 1952. No cuts have yet been obtained, but scorings of growth show that benefits can be obtained from fertilizer dressings on Lucerne at least during establishment.

C.—Undersowing

Four small 1/55 acre plots were sown on 28th July, 1952, with *Phalaris tuberosa* at 15 lb/acre broadcast; two of the plots were oversown with oats at 1½ bushels/acre broadcast, and the oats cut at the milky stage. There was no establishment of *Phalaris* when undersown.

Minimum night temperatures at ground level were recorded for ten nights in August and September on the plots. The average minimum temperature was 39.5° F., with a range of 33° to 47° F. This may be compared with nearby bare ground records, which for July averaged 39° F. (range 32° F. to 53° F.) and 37° F. for August (range 36° F. to 44° F.). The combination of low temperatures with weed competition may make undersowing difficult in these areas.

D.—Collection Plots

Four of these were established on farms by Mr. H. J. Millachip (Assistant Agricultural Officer, i/c Co-operative Experiments) at the places detailed below:—

(1) *Njoro* (by courtesy of Mr. D. Broatch).
Altitude, 7,200 feet.
Rainfall for 1952, 26 inches.
Soil type, Njoro tuff.

(2) *Elburgon* (by courtesy of Mr. R. A. Clay).
Altitude, 7,700 feet.
Rainfall for 1952, 30 inches.
Soil type, dark brown forest loam.

(3) *South Kinangop* (by courtesy of Mr. H. C. Nightingale).
Altitude 8,300 ft. approximately.
Rainfall for 1952, 31.42 inches.
Soil type, light brown loam.

(4) *North Kinangop* (by courtesy of Mr. N. H. Lee).
Altitude 8,400 ft. approximately.
Rainfall for 1952, 40.62 inches.
Soil type, grey clay.

Observations on the more important species are tabulated below:—

*K*31 *Fescue*

Practically no take obtained at Njoro; undoubtedly due to the low rainfall. The best growth was at Elburgon (despite a dry year) where there was good growth and yield 4½ months after sowing (7 in. of leaf) when the plants started to flower.

Good growth was also obtained on the North Kinangop 5 months after sowing. Growth on the South Kinangop was very slow, a fair bite being available 7½ months after sowing.

Cocksfoot

Practically no take was obtained at Njoro. Growth was worst on the North Kinangop where early sown Commercial Cocksfoot took 7 months to provide a fair bite, and late sown Akaroa and Olsgaard took 5½ months to reach the same stage.

There was little difference between growth rates at Elburgon and the South Kinangop, 5 months being required for the plants to produce a good yield (6 in. of leafage).

Of the strains under observation, the Akaroa strain was most promising from the herbage point of view; this is a comparatively fine-leaved Cocksfoot which did not flower during 1952. The S37, Pasture/Hay, Olsgaard and Commercial strains flowered quite vigorously and were perhaps slightly earlier growers than the Akaroa. There were no appreciable differences between the estimated yields of the various strains.

Serradella

This grew outstandingly well on the grey clay soil of the North Kinangop, a 2 ft. high mat of growth being obtained 5 months from sowing. Growth at the other plots stopped at the 1 ft. stage, except for Njoro where only 7 in. growth was recorded. Seeding was good at all plots.

Sweet Clovers

Madrid, Evergreen, Yellow sweet and Hubam clovers were sown, but the first three (prostrate types) were not promising on any of the plots. The Hubam clover, an erect type which grows up to 5 ft. tall, grew particularly well at Elburgon and has possibilities for silage. The Hubam flowered and seeded well, while the others did not.

Phalaris tuberosa

Practically no take obtained at Njoro. Best growth on South Kinangop where a good yield was obtained 5 months after sowing. Growth at Elburgon was good but the plants were not standing the dry weather well in September. Growth was very yellow on the North Kinangop. Good flowering was observed during December on the South Kinangop, but it was poor elsewhere.

Red Clovers

No take was obtained at Njoro. Aberystwyth broad red clover produced a good stand 1 ft. high on the North Kinangop, compared with only 3 in. and 6 in. of growth of late flowering red clover and Dorset red clover respectively. Growth of the late flowering red clover was poor at Elburgon and South Kinangop. No flowering was observed on any of the plots.

Cynodon dactylon

A comparison of Naivasha star and Ol Joro Orok star grass on the Kinangop showed that the latter may have possibilities on the brown soils where growth was good. A giant strain of *Cynodon* was established well from seed at Elburgon.

Subterranean Clover

Mount Barker strain grew well at all places except Njoro; 6 in. to 8 in. of leafage was produced some 5 months after sowing, except on the North Kinangop where growth was up to 1 ft. high and a 100 per cent cover obtained. On the North Kinangop a comparison between Mt. Barker, Yarloop and Talarook showed marked strain differences; Talarook grew poorly (up to 4 in. in height) and then started to brown off slightly on 14th December, 1952, on which date the Yarloop was completely brown, compared with Mt. Barker which was still green.

Miscellaneous

Trials of Molasses grass, Rhodes grass, *Setaria sphacelata, Glycine javanica,* perennial *Dolichos,* and *Vigna* sp. were a failure on the North Kinangop. Although the legumes germinated, growth to date has been very poor.

Molasses grass took well, though very slowly, on the South Kinangop.

Conclusion

To sum up; these collection plots have demonstrated the differing reactions shown by species and strains when grown in various climates and under differing soil conditions.

N.B.—All plots were sown with 2 cwt. Single Superphosphate/acre.

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ANNUAL REPORT OF THE PASTURE RESEARCH CHEMIST, 1952

The scope of the work undertaken during the year may be reviewed under four headings:—

(i) Chemical analyses of herbage samples obtained from co-operative field experiments on ley establishment begun in 1952, and from field experiments on natural and established pastures begun in 1951.

(ii) Preliminary observations on the B–carotene content of certain grasses and legumes, and the effect on this constituent of N and P fertilizers when they are applied to natural and established pastures.

(iii) The composition of Kikuyu grass at high altitudes.

(iv) Miscellaneous analyses of different herbage species, including legumes.

Field Experiments on Ley Establishment

In a series of field experiments begun in 1951 throughout the Kenya Highlands, it was shown that phosphorus was essential to successful ley establishment and that nitrogen too was beneficial. The fertilizers supplying these elements, single superphosphate and sulphate of ammonia, were applied only to the seedbed. The marked responses to these fertilizers which were obtained from the first herbage cut were not reproduced in subsequent cuts, although it was found that the phosphate fertilizer continued to enhance the P_2O_5 content of the herbage. It was postulated that if a basal application of fertilizers were to be augmented—for example by again applying them immediately after the first herbage cut—establishment of a young sward might continue with enhanced vigour and productivity, provided other factors such as rainfall were favourable. In order to test this view-point, a small number of field experiments was begun in 1952. They were composed of factorial combinations of three levels of P, three levels of N and three herbage species each with the same companion legume. There were two replications. The rates of application of the fertilizers were—

single superphosphate 0, 54, 108 lb. P_2O_5 per acre.

sulphate of ammonia 0, 30, 60 lb. N per acre.

The grasses were Rongai Rhodes, Nzoia Rhodes and Alego Rhodes, each of which was sown with Lucerne. All P plots were split so that half received the phosphatic fertilizer at the appropriate level in full, and half received one-third only of this amount. The remaining two-thirds were to be applied in two equal increments after taking the first and the second herbage cut respectively. Nitrogen was applied to the seed bed of appropriate plots and again after each herbage cut. All plots were cut by autoscythe when they reached a stage of growth suitable for stock grazing.

At the end of the growing season, herbage-yield data were available for two cuts taken from one experiment and for the initial cut of a parallel experiment.

For the first of these experiments, the time which elapsed between sowing and cutting, on the first and second occasion respectively, is shown in days in the accompanying table; the number of plots harvested on each cutting date is given contiguously in brackets; the rainfall during respective periods of growth is shown also:—

TABLE I—TIME AND RAINFALL BETWEEN SOWING AND CUTTING

Date of sowing and applying fertilizers, 10th May, 1952

	Days (From sowing to Harvesting)		Rainfall (From sowing to Harvesting)	
	Cut 1	Cut 2	Cut 1	Cut 1
Rongai Rhodes and Lucerne ..	89 (5)	129 (5)	7·99	13·55
	100 (3)	137 (2)	8·87	14·08
	100	149 (1)	8·87	14·89
	105 (1)	149 (1)	9·66	14·54
Nzoia Rhodes and Lucerne	89 (4)	129 (1)	7·99	13·55
	89	137 (3)	7·99	13·73
	100 (4)	137 (2)	8·87	14·08
	100	149 (1)	8·87	14·89
	100	172 (1)	8·87	15·58
	105 (1)	172 (1)	9·66	15·23
Alego Rhodes and Lucerne	89 (5)	129 (1)	7·99	13·55
	89	137 (3)	7·99	13·73
	89	158 (1)	7·99	14·54
	100 (3)	149 (1)	8·87	14·89
	100	149 (1)	8·87	14·89
	100	187 (1)	8·87	15·58
	105 (1)	187 (1)	9·66	15·23

The three ley mixtures, initially, shared three dates of cutting in common. Regrowth following upon defoliation apparently was variable as reflected in the widely different intervals which elapsed before a second herbage cut was achieved. It would appear that rainfall may be associated with time taken for recovery, for plots which were late on the first occasion again came late to maturity a second time and during a period when rainfall was becoming less favourable.

Data in the following tables are produced to illustrate how applications of P and N fertilizers to the seed bed assisted to promote maturity, in the sense of "readiness for cutting". The number of plots which received P and/or N—independent of the rate of application—are shown below the date on which they were cut:—

TABLE II—NUMBER OF PLOTS CUT ON RESPECTIVE CUTTING DATES

1st Cut

	7th August			18th Aug.		23rd August		
	P	N	(O)	P	N	P	N	(O)
(*a*) Rongai Rhodes and Lucerne ..	5	4	—	1	2	0	0	1
(*b*) Nzoia Rhodes and Lucerne ..	4	3	—	2	3	0	0	1
(*c*) Alego Rhodes and Lucerne ..	3	3	—	3	3	0	0	1

2nd Cut

	16th Sept.		24th Sept.		6th Oct.			15th Oct.		29th Oct.			13th Nov.		
	P	N	P	N	P	N	(O)	P	N	P	N	(O)	P	N	(O)
(*a*)	5	4	0	2	1	0	1	—	—	—	—	—	—	—	—
(*b*)	1	1	4	4	0	1	—	—	—	1	0	1	—	—	—
(*c*)	0	1	2	2	1	1	—	2	1	—	—	—	1	1	1

Control plots (O) were the last to be cut on both occasions. Plots receiving fertilizers, on the other hand, matured much earlier in both cuts although Alego Rhodes and Lucerne behaved erratically in the second cut.

Detail similar to that given above is reproduced for the parallel experiment sown on 22nd May for which records of one cut only are available; the following table shows dates of cutting and the number of plots harvested on each date. The rainfall between sowing and harvesting is also shown.

TABLE III—TIME AND RAINFALL BETWEEN SOWING AND CUTTING AND NUMBER OF PLOTS CUT

Date of Sowing, 22nd May, 1952

Date of Cutting	5th Aug. Day 75	2nd Sept. Day 103	18th Sept. Day 119	26th Sept. Day 127	29th Sept. Day 130
(*a*) Rongai Rhodes and Lucerne ..	6	3	—	—	—
(*b*) Nzoia Rhodes and Lucerne ..	5	1	2	1	—
(*c*) Alego Rhodes and Lucerne ..	0	4	2	2	1
Rainfall from 22nd May to ..	6·06	8·93	11·57	11·57	11·57

The number of plots which received P and/or N are shown below, together with the dates on which they were cut.

	5th Aug.		2nd Sept.			18th Sept.		26th Sept.			29th Sept.	
	P	N	P	N	O	P	N	P	N	O	P	N
(*a*)	6	4	0	2	1	—	—	—	—	—	—	—
(*b*)	5	4	1	0	—	0	2	—	—	1	—	—
(*c*)	—	—	4	4	—	2	0	0	1	1	0	1

In this experiment also, plots which received P and/or N fertilizers matured more rapidly. The slower-growing plots, to which Alego Rhodes and Lucerne contributed largely, came to maturity under conditions of unfavourable rainfall.

Mean yields of fresh herbage are given below for the initial cut of each experiment and for the second cut of one experiment.

TABLE IV—YIELD OF FRESH MATERIAL—1ST CUT

(*tons per acre*)

Rongai Rhodes and Lucerne

	PO	P18*	P36*	P54	P108	NO	N30	N60
Expt/1	4·13	3·69	5·49	4·94	5·34	3·87	5·36	4·92
2	2·20	1·57	2·94	3·62	4·16	2·47	2·81	3·21

Nzoia Rhodes and Lucerne

Expt/1	4·91	4·23	4·07	5·11	5·09	3·96	4·43	5·66
2	2·35	1·81	2·29	2·65	4·21	2·62	2·81	2·56

Alego Rhodes and Lucerne

Expt/1	3·94	3·12	4·29	4·22	4·53	3·15	4·39	4·52
2	2·33	2·35	2·58	3·57	4·22	2·69	2·80	3·57

(* Dressings of one-third of the total P_2O_5 allocation.)

2ND CUT

Rongai Rhodes and Lucerne

	PO	P36*	P54	P72*	P108	NO	N30	N60
Expt/1	1·43	4·77	4·30	6·00	5·55	2·26	4·98	6·56

Nzoia Rhodes and Lucerne

Expt/1	3·12	3·64	2·76	3·46	2·81	1·92	3·40	4·16

Alego Rhodes and Lucerne

Expt/1	3·60	2·82	3·16	2·22	2·33	2·26	1·89	4·33

(* Dressings of two-thirds of the total P_2O_5 allocation.)

Results of visual observations before plots were harvested suggested that plant growth was more vigorous where complete dressings of the phosphatic fertilizer, together with nitrogen, had been applied to the seed-bed. No growth differences were detectable on plots which had received different amounts of nitrogen together with the same amount of phosphorus. Yield data have confirmed the general accuracy of these observations. The yields obtained from P applied at 108 lb. P_2O_5 per acre, however, cannot justify this high initial dressing in the presence or absence of N. Phosphorus at 54 lb. P_2O_5 per acre and at 36 lb. (= one-third of the 108 lb. P_2O_5 per acre dressing) on the whole were beneficial in the presence of N. On the other hand, P at 18 lb. P_2O_5 (= one-third of the 54 lb. P_2O_5 per acre dressing) almost consistently depressed yields in the absence of N and rarely caused an increase in its presence.

The general effect of N in the presence of P was to increase slightly the yield of herbage obtained in the first cut. Sulphate of ammonia applied at 30 lb. N per acre to the seed-bed appeared to be an adequate dressing.

After the first cut half plots which were entitled to receive it, were augmented by their first increment of P at the rate of one-third of their total P_2O_5 allocation. Nitrogen was applied again to appropriate plots at the original rate.

In the second cut, two of the three ley mixtures gave greater herbage-yield responses to P where it had been applied as an increment. In respect of Alego Rhodes and Lucerne, however, yields were depressed at every level of P, irrespective of how it had been applied. The yield data continued to support the view that the full, initial dressing of 108 lb. P_2O_5 per acre was excessive and indeed, only the case of Rongai Rhodes and Lucerne could justify the initial dressing of 54 lb. P_2O_5.

Response to N in the presence of P was greater in this cut than it was in the initial cut but control yields on the other hand were smaller.

Estimations were made of the Crude Protein and Phosphorus constituents in the herbage harvested from the initial cut of both experiments. Mean values obtained for these constituents at each level of P and N applied are given below.

TABLE V—COMPOSITION OF HERBAGE HARVESTED FROM THE 1ST CUT

Rongai Rhodes and Lucerne

Crude Protein—(per cent of Dry Matter)

	PO	P18	P36	P54	P108	NO	N30	N60
Expt/1	14·00	13·36	12·92	12·52	9·27	12·32	10·69	14·23
2	12·92	14·69	14·26	16·97	11·50	14·05	12·77	15·40

P_2O_5—(per cent of Dry Matter)

Expt/1	0·40	0·31	0·18	0·28	0·20	0·29	0·22	0·25
2	0·20	0·29	0·38	0·24	0·28	0·26	0·26	0·31

Nzoia Rhodes and Lucerne

Crude Protein—(per cent of Dry Matter)

Expt/1	14·20	11·04	10·61	11·93	11·13	12·15	9·87	13·32
2	9·83	13·34	15·68	13·84	13·40	11·98	13·60	14·07

P_2O_5—(per cent of Dry Matter)

Expt/1	0·27	0·18	0·25	0·16	0·31	0·33	0·18	0·20
2	0·18	0·24	0·13	0·26	0·35	0·24	0·27	0·18

Alego Rhodes and Lucerne

Crude Protein—(per cent of Dry Matter)

Expt/1	15·91	14·79	15·52	16·95	14·12	12·96	15·25	18·16
2	15·00	12·52	nd.	11·79	nd.	12·40	11·60	nd.

P_2O_5—(per cent of Dry Matter) . .

Expt/1	0·17	0·21	0·17	0·18	0·28	0·16	0·18	0·27
2	0·10	0·23	nd.	0·29	nd.	0·24	0·28	nd.

Crude Protein values were higher for Alego Rhodes and Lucerne than for the two other mixtures.

Added P caused a decrease in the crude protein content of the herbage, an effect which was in accord with results obtained in 1951. The P_2O_5 content of all herbage was extraordinarily low, although added P tended to increase it slightly.

Nitrogen at the higher level of application increased the crude protein content of two of the ley mixtures and markedly increased it in Alego Rhodes and Lucerne.

In the two ley-establishment experiments reported, the evidence available would appear to indicate that the principal effect of P and of N was to promote earlier maturity. The fertilizers had slight effect on productivity and on nutrient value of herbage harvested in the initial cut but N, in the presence of P, caused substantial increases in productivity in the second cut. The evidence appears to suggest that where maturity does not obtain early, subsequent regrowth may be retarded by circumstances of inadequate rainfall.

Effect of Fertilizers on Natural and Established Pastures

Field experiments under this heading were begun in 1951. Details of fertilizer treatments, of experimental layout, of herbage and soil sampling techniques, together with the results obtained, were reported last year (1). Five of these experiments were continued during the year under review. To each of them the phosphatic and the nitrogenous fertilizers were applied at the appropriate levels at the beginning of the growing season. Nitrogen only was applied again after the first herbage cut was taken. Tables VI and VII show mean yields of dry matter obtained from the first and second cut of these experiments: increments of N occur as lb. N per acre and increments of P as lb. P_2O_5 per acre.

TABLE VI—MEAN YIELD OF DRY MATTER—1ST CUT

(*Tons per acre*)

	NO	N15	N30	N60	N90	N120	Mean
PO	0·51	0·69	0·77	0·92	1·07	1·28	0·87
P36	0·45	0·76	0·96	1·19	1·36	1·27	1·00
P72	0·51	0·72	0·97	1·24	1·46	1·31	1·03
Mean	0·49	0·72	0·90	1·12	1·29	1·29	

TABLE VII—MEAN YIELD OF DRY MATTER—2ND CUT

(*Tons per acre*)

	NO	N15	N30	N60	N90	N120	Mean
PO	0·37	0·52	0·63	0·80	0·82	0·90	0·67
P36	0·33	0·64	0·90	1·16	1·25	1·25	0·92
P72	0·44	0·62	0·89	1·14	1·62	1·44	1·02
Mean	0·38	0·59	0·81	1·03	1·23	1·19	

Effect of Nitrogen

The data in these tables show how yields of dry matter are related to each increment of N at each increment of P applied. Response to N in both cuts is similar to, and follows closely, the logarithmic response curves obtained last year.

Added N increased not only the percentage of crude protein contained in the herbage but the yield of crude protein removed in the herbage, as the following figures show: —

TABLE VIII—ADDED N AND CROSS PROTEIN

ADDED N (*lb. N per acre*)	CRUDE PROTEIN (*a*) *per cent of dry matter*	(*b*) *Yield* (*cwt. per acre*)
0	11.62	1.14
15	11.78	1.70
30	11.78	2.12
60	12.69	2.84
90	14.09	3.64
120	14.97	3.86

(*a*) regression coefficient = 0.0927
correlation coefficient r = 0.980

(*b*) regression coefficient = 0.0011
correlation coefficient r = 0.992

The N applied caused a decrease in the percentage of phosphorus contained in the herbage, viz.: —

TABLE IX—ADDED N AND P_2O_5 CONTENT OF THE HERBAGE

ADDED N (*lb. N per acre*)	P_2O_5 (*per cent of Dry Matter*)
0	0.69
15	0.68
30	0.67
60	0.62
90	0.61
120	0.59

correlation coefficient, r = 0.974; regression coefficient = 0.000884

The yield of P_2O_5 removed in the herbage, on the other hand, was increased by the N applied, as the figures in the following table show: —

TABLE X—ADDED N AND P_2O_5 REMOVED IN THE HERBAGE

ADDED N (*lb. N per acre*)	P_2O_5 (*lb. per acre*)
0	7.12
15	10.72
30	13.05
60	14.85
90	16.65
120	16.10

The P_2O_5 yield-response curve obtained from these data is very similar to the dry-matter logarithmic response curve reported earlier.

The adverse effect of sulphate of ammonia on soil reaction was again demonstrated. Data given in the following table show how fall in pH is related to each increment of N applied.

TABLE XI—ADDED N AND pH

ADDED N (*lb. N per acre*)	*pH*
0	5.79
15	5.73
30	5.62
60	5.57
90	5.48
120	5.39

correlation coefficient, r : –0.984; regression coefficient : –0.0032

Effect of P

Results for 1951 were confirmed when it was found once more that added P increased the production of dry matter from natural and established pastures. This year, however, mean responses to P were greater in the second cut than in the first.

The percentage of crude protein contained in the herbage was decreased by the P added, but the yield of crude protein was increased slightly—

TABLE XII—ADDED P AND CRUDE PROTEIN

ADDED P (*lb. P_2O_5 per acre*)	CRUDE PROTEIN	
	Per cent of dry matter	*Yield (cwt. per acre)*
0	13.02	2.26
36	12.93	2.58
72	12.48	2.56

The percentage of P_2O_5 contained in the herbage, and the yield of P_2O_5 removed by it, were both increased at each increment of P applied, as the following data show:—

TABLE XIII—ADDED P AND P_2O_5

ADDED P (*lb. P_2O_5 per acre*)	P_2O_5	
	Per cent of dry matter	*Yield (lb. per acre)*
0	0.54	10.12
36	0.69	14.32
72	0.71	16.10

pH and P

In 1951, the year fertilizers were applied initially, it was shown that the herbage-yield response to Added P was related to pH. Greater responses over control yields of fresh herbage were obtained from soils of relatively low pH than were obtained from soils of higher pH. No such convincing results were obtained this year, but a perusal of the data given in the table will indicate that the same trend is evident. It would appear nevertheless that under the conditions of these experiments, where an annual dressing of phosphorus has been applied to the pastures, pH cannot be used satisfactorily to predict other than their initial need for this element.

TABLE XIV—pH AND RESPONSE TO P

pH	*Control Yield of Fresh Herbage (PO) (Tons per acre)*	ADDED P *P.36–PO*	*P.72–PO*
5.41	1.79	1.60	1.81
5.44	4.01	1.38	1.89
5.64	4.98	–0.02	0.45
5.95	7.28	1.13	0.64
6.37	1.49	0.04	0.07

correlation coefficients: r = –0.625, r = –0.854

Whereas the relationship yield-response to P and pH was not confirmed during the second year, P_2O_5 uptake in the herbage and pH were found to be related. Data in Table XV shows how the difference over control in the percentage P_2O_5 content of the herbage is related to pH at each increment of P applied.

TABLE XV—pH AND THE PERCENTAGE DIFFERENCE IN THE P_2O_5 UPTAKE IN THE HERBAGE

pH	P_2O_5 *(per cent of dry matter)* *P.36–PO*	*P.72–PO*
5.41	0.20	0.28
5.44	0.17	0.27
5.64	0.14	0.21
5.95	0.14	0.24
6.37	0.09	–0.13

P.36–PO correlation coefficient r = –0.930
regression coefficient = –0.0945

P.72–PO correlation coefficient r = –0.787
regression coefficient = 0.3783

The relationship which was obtained last year between response to P, and rainfall, was not confirmed. Table XVI gives the data applicable to the first herbage cut made in 1952.

TABLE XVI—RAINFALL AND RESPONSE TO P

RAINFALL *during the month prior to cutting*	CONTROL YIELD *(tons dry matter per acre)*	RESPONSE TO P *P.36–PO*	*P.72–PO*
2.95	0.63	0.04	0.07
4.36	1.48	1.13	0.64
5.17	0.46	1.60	1.81
6.93	0.97	–0.02	0.45
7.78	0.82	1.38	1.89

The importance of rainfall to plant growth and to productivity nevertheless was illustrated very markedly in the behaviour of two Star grass pastures in 1952. The circumstances are outlined below:—

Locality	Altitude	pH	Date of 1st Cut	Date of 2nd Cut	Total Rainfall 1st Cut	Total Rainfall 2nd Cut
	ft.					
Bahati ..	7,000	5·95	1st July	15th Sept.	22·11	35·20
Gilgil ..	6,000	6·37	5th June	1st Oct.	8·55	12·00

Response to N and P fertilizers in combination, under these conditions were as follows:—

TABLE XVII.—RESPONSE OF STAR GRASS TO N AND TO P

Mean Yield of Dry Matter (Tons Per Acre)

	1ST CUT		2ND CUT	
	Bahati	*Gilgil*	*Bahati*	*Gilgil*
NO	0.78	0.21	0.68	0.04
N.15	1.17	0.45	1.05	0.05
N.30	1.39	0.64	1.28	0.10
N.60	1.85	0.81	1.79	0.13
N.90	2.16	0.81	2.09	0.17
N.120	2.41	0.82	2.33	0.16
PO	1.48	0.63	1.22	0.11
P.36	1.73	0.59	1.61	0.09
P.72	1.67	0.64	1.77	0.12

B-carotene

The method of Nelson (*The Analyst*, 1945) was adopted for extracting B-carotene from plant material, but it was found necessary to increase by 20 minutes the time he allowed for extraction, in order to obtain greater efficiency at this altitude. The estimations were made colorimetrically, varying dilutions of pure B-carotene having been related previously to Lovibond Tintometer readings in Yellow Units: the curve obtained was identical to that given by Ferguson (*The Analyst*, 1935).

The first experiment was made in order to study the carotene content of different herbage species at intervals after they were cut and allowed to air-dry in the absence of direct sunlight. Four indigenous grasses which had reached approximately the same leafy stage of growth, and one legume, were cut on the same day. Leaf material only was used in subsequent determinations of carotene, of air-dry material and of dry matter. Table XVIII shows some of the results obtained from this experiment. B-carotene values are expressed as mgm. per kilo of dry matter.

TABLE XVIII—THE EFFECT ON B-CAROTENE OF AIR-DRYING HERBAGE

Day	*Molasses Grass*	*Guinea Grass*	*Star Grass*	*Rhodes Grass*
1	185	180	277	331
9	144	123	229	141
18	102	87	208	137

The overall effect of air-drying the grasses was clearly to cause a reduction in their carotene content, but minor fluctuations were found to occur occasionally between the days shown. It could be expected that had air-drying been allowed to take place in the presence of direct sunlight, loss of carotene would have been more dramatic. In the case of the legume (*Indigofera subulata*) it was found that an initial loss from 230 mgm. per kilo on day 1 to 181 on day 9 was followed by a rise to 269 on day 18. No explanation of this anomaly is proposed in the absence of further data.

Several miscellaneous determinations followed, and results from three of these are shown in the tables below to illustrate the propositions that B-carotene is associated essentially with vital processes occurring in plants, that it occurs usually in greater proportion in the leaf than in the stem (Table XX) and that it enhances the biological value of a mixed sward (Table XXI). Table XIX shows the B-carotene content of vital tissues and of dead tissues both of which formed part of the same plant of unmanaged Kikuyu grass. All results which follow are expressed as mgm. per kilo of air-dry material.

TABLE XIX—B-CAROTENE IN KIKUYU GRASS

Dead Tissues	*Vital Tissues*
10	30

TABLE XX—B-CAROTENE IN MATURE LUPINS

Stem	*Leaf and Stem*
75	205

TABLE XXI—B-CAROTENE IN A MIXED SWARD

Kikuyu Grass Alone	*Kikuyu Grass Mixed with Clover*
255	298

The effect of fertilizers on the B-carotene content of natural and established pasture herbage was studied, and data given below indicate how P and N fertilizers may be expected to enhance this component. These results were obtained from a Rhodes grass pasture on the farm of Major Dudgeon, of Rongai, and are expressed as mgm. per kilo of air-dried grass.

TABLE XXII—THE B-CAROTENE CONTENT OF A RONGAI RHODES PASTURE AS AFFECTED BY P AND N

	NO	N15	N30	N60	N90	N120	Mean
PO	65	70	85	85	108	95	64
P36	65	79	95	122	118	122	100
P72	70	90	82	122	118	122	100
Mean	66	79	87	109	114	113	

Kikuyu Grass at High Altitudes

It is a matter for concern to farmers at the higher altitudes that a tumble-down temporary or permanent pasture of Kikuyu grass cannot remain vigorous and productive for many years. Attention has been given to seeking possible causes for this decline by studying the variation in chemical composition of an affected sward and, in contrast, a healthier sward. The farm of Mr. J. F. Lipscomb, situated at an altitude of 8,300 ft. on the South Kinangop, was selected as being in every way suitable for this work.

Examination of an unproductive sward on this farm showed that a turf-horizon of 3–4 in. of densely matted roots had developed: in these circumstances a consequent lack of soil and root aeration could reasonably be inferred. The indigenous clover normally found at this altitude was excluded from the sward. The healthier pasture on the other hand contained an abundance of clover but its feebly-nodulated rooting system was shallow, poorly-developed, and tending to become swamped in an apparently progressive process of mat-formation. No doubt in a short time a turf-horizon entirely excluding clover will result, provided edaphic and biotic factors remain unchanged.

A climatic factor characteristic of the Kinangop is the prevalence of ground-frosts. These occur with varying degrees of severity, usually between December and the end of February. An effect of frost on a declining Kikuyu grass sward can be to retard growth so profoundly as to render the pasture unproductive for the greater part of the following growing season. Occasionally, too, a late frost following defoliation (i.e. by grazing new-growth Kikuyu grass on a healthier sward

earlier in the season) may prevent the grass from recuperating during that season. In these circumstances, a clover-dominant sward may arise temporarily, for the slower-growing legume at this stage is largely unaffected by frost. Later in the season, however, a single severe frost may reduce this clover overnight to almost worthless herbage.

Chemical analysis has revealed considerable differences in the composition of the soil supporting the declining sward and the soil of the healthier sward, as data in the following table show:—

TABLE XXIII—COMPOSITION OF AIR-DRY SOIL

	Soil From—	
	the declining pasture	*the healthier pasture*
pH	4.8	5.9
Nitrogen per cent	0.59	0.56
Organic carbon per cent	7.41	5.91
CaO (mg. equivalent per 100 g.) ..	1.17	24.35
K_2O (mg. equivalent per 100 g.) ..	1.63	2.96
Total exch. bases (M.E. per 100 g.)	3.84	27.62

In both soils, readily available P_2O_5, as assessed by the rapid method of Bray, was low.

Chemical analysis of the herbage, which was sampled at approximately monthly intervals, showed that the percentage of crude protein and of lime contained in the healthier sward was greater than in the declining sward. On the other hand, the declining sward contained a larger percentage of phosphorus, but was more fibrous. Table XXIV shows the mean values obtained for these constituents over a period of five consecutive months.

TABLE XXIV—KIKUYU GRASS—PER CENT OF DRY MATTER

	Crude Protein	*Crude Fibre*	*CaO*	*P_2O_5*
The healthier pasture ..	14.52	23.65	0.52	0.51
The declining pasture ..	11.32	26.28	0.39	0.61

The effect of the legume as a component of the healthier sward was entirely beneficial and this is illustrated in the following table where the composition of Kikuyu grass alone is compared with the composition of a mixture of grass and clover. These data were obtained from samples taken in October and December, 1952.

TABLE XXV—ANALYSIS OF KIKUYU GRASS AND KIKUYU GRASS WITH CLOVER—PER CENT OF DRY MATTER

	Crude Protein		Crude Fibre		CaO		P_2O_5	
	Oct.	Dec.	Oct.	Dec.	Oct.	Dec.	Oct.	Dec.
Grass alone ..	12·22	13·01	25·00	22·81	0·41	0·68	0·43	0·28
Grass and Legume	13·91	18·62	22·29	19·11	1·14	1·24	0·49	0·38

The percentage of each mineral and crude protein is greater in the mixed herbage than in the grass alone, and crude fibre is lower.

The evidence available would appear to suggest that several interrelated factors are concerned in the decline in vigour and productivity of Kikuyu grass at high altitudes. Those listed below are considered relevant:—

(1) Low soil nutrient status.

(2) Mat formation and consequent lack of soil and root aeration.

(3) Climatic environment (especially the effect of frost).

(4) Grazing management, the aim being not to defoliate the young herbage too drastically early in the season.

In view of the urgent need to find effective practical methods for regenerating the grass, field experiments are to be started in 1953 in which measures are directed in the first instance to—

(i) breaking up existing matted swards by ploughing and by severe ripping treatments;

(ii) improving soil nutrient status by using fertilizers and adjusting soil reaction (pH) by using an amendment, e.g. carbonate of lime.

Parenthetically, it was noted during the course of this study that a relationship exists between the crude protein content of the Kikuyu grass and its corresponding carbohydrate value. The figures given in Table XXVI show that as the crude protein content of the grass increases, its carbohydrate content decreases.

TABLE XXVI—KIKUYU GRASS—RELATIONSHIP BETWEEN CRUDE PROTEIN AND CARBOHYDRATE

(*Per Cent of Dry Matter*)

Crude Protein			*Carbohydrate*
6.86	..	..	54.07
8.80	..	..	52.30
9.25	..	..	51.38
11.36	..	..	49.95
12.22	..	..	49.95
13.30	..	..	49.26
16.87	..	..	45.09

Miscellaneous Analyses

Table XXVII gives data on the principal constituents of certain exotic and indigenous herbage species at a specific stage in their growth. Most samples were obtained when growth was active and this is reflected generally in their high content of crude protein. The relatively low content of crude protein found in *Setaria* may be ascribed to the mature state of its growth. The very low crude protein value obtained for the Molo sample of short Kikuyu grass forms part only of a general problem involving the maintenance of this grass at high altitudes, a subject discussed earlier in this report. The crude protein content of the indigenous clover from Ol Joro Orok is seen to fall markedly as the season advances.

The lime (CaO) content of the legumes is very high and that of the grasses is at a reasonable level.

The phosphorus (P_2O_5) content of many of the grasses is disappointingly low, and in the clovers it is not particularly high.

TABLE XXVII—MISCELLANEOUS ANALYSIS

Locality	Species	Stage of Growth	Date Cut	Crude Protein	P_2O_5	CaO
				Per cent of Dry Matter		
Molo	Kikuyu Grass	3″ leaf, much stem, yellow leaf	28th Sept.	5·08	0·15	0·75
Molo	Kikuyu Grass	18″, Vigorous, erect, green leaf	,,	13·87	0·25	0·49
Elburgon	Cocksfoot	6″ leaf	22nd Sept.	21·19	0·48	0·50
South Kinangop	Cocksfoot (Akaroa)	9″ leaf	30th Sept.	14·68	0·58	0·56
South Kinangop	Red Fescue (Rodsvingel)	4–6″ fine leaf	,,	18·64	0·43	0·48
South Kinangop	Alta Fescue	9″ leaf	,,	15·49	0·51	0·37
Elburgon	Alta Fescue	6″ leaf	22nd Sept.	12·31	0·15	0·48
South Kinangop	K31 Fescue	6–8″ leaf	30th Sept.	15·33	0·20	0·57
Elburgon	K31 Fescue	7″ leaf	22nd Sept.	16·97	0·27	0·58
South Kinangop	Italian Ryegrass	12″ leaf	30th Sept.	16·15	0·77	0·43
South Kinangop	Phalaris	12″ leaf	,,	15·25	0·40	0·41
Elburgon	Setaria acqualis	24″ hay	22nd Sept.	10·32	0·22	0·36
Elburgon	Molasses	6″ leaf	,,	9·27	0·11	0·39
Elburgon	Serradella	6″ leaf	26th Aug.	20·82	0·33	2·43
Elburgon	Sweet Clover (Huban)	12″ leaf and stem	,,	19·85	0·18	2·49
Ol Joro Orok	Dolichos (ex Kilima Kiu)	18″ leaf and stem	5th May	18·49	0·46	2·09
Ol Joro Orok	White Clover (Indigenous)	Leaf and stem	7th Aug.	25·07	0·85	1·88
Ol Joro Orok	White Clover (Indigenous)	Leaf and stem	5th Sept.	20·45	0·44	1·83
Ol Joro Orok	White Clover (Indigenous)	Leaf and stem	10th Oct.	17·77	0·33	1·95

H. W. DOUGALL,
Pasture Research Chemist.

ANNUAL REPORT OF THE ASSISTANT AGRICULTURAL OFFICER, PASTURE RESEARCH, KABETE, 1952

Meteorological Data

The total rainfall at the station in 1952 was 33.06 in. which compares with an average at the Veterinary Laboratories, Kabete, of 37.5 in. over the previous 20 years. 24.54 in. fell during the long rains, March–July, and 4.97 in. during the short rains. October–December.

Closing Down of Sub-station

Early in 1952 it was decided to close down this sub-station; in view of this no new experimental work was undertaken, and no material was planted during the year. Work during the year was restricted to the following:—

1. Seed production of grasses and legumes, with special attention to *Dolichos* sp. ex Kilima Kiu, and indigenous legumes introduced by the Botanist.
2. Seed production of Improved Kavirondo Perennial Sorghum.
3. The transfer to Kitale and Marindas of planting material of every species growing here.
4. Grazing and observation on existing established plots, on which experimental work was discontinued.
4. Planting of plots on Athi Plains.
6. Rhodes grass seed production at Thika. (*See* separate report.)

List of species from which seed has been harvested

Bothriochloa insculpta.
Melinis minutiflora (Chania strain).
Setaria sp. (ex Nandi).
Cenchrus ciliaris (erect form).
Chloris Gayana (Alego strain).
Hyparrhenia lintonii.
Chrysopogon aucheri.
Andropogon schinzii.
Dolichos sp. (ex Kilima Kiu).
Indigofera retroflexa.
Glycine javanica.
Indigofera tettensis.
Alysicarpus glumaceus.

Improved Perennial Kavirondo Sorghum.
Perennial Sorghum—three selected types.

Chloris gayana—Alego Strain.—2 acre plot at Lower Farm, Veterinary Laboratory

This plot was established during 1950 as a seed bulking and grazing trial plot at the Artificial Insemination Centre farm, about two miles from the main experimental plots, with seed which it is understood Mr. D. C. Edwards collected from Alego in Nyanza Province. Seed was collected from this plot during 1951, by which time it was fully established. The two acres were grazed by 20–25 cattle for 20 days during April and May of 1952. This provided a total of 473 grazing days.

It was planned to collect more seed after the 1952 short rains, but the early cessation of the long rains and partial failure of the short rains caused a very poor crop. This strain of Rhodes grass has proved to be very promising; it appears to have finer leaves than Nzoia, and in this particular case to have formed a closer sward. The grazing record for the one period above is good. It was kept in co-operation with Mr. North Lewis, Livestock Officer, Central Insemination Centre. It is hoped that it will be possible to continue to keep this plot under observation and to keep grazing records, and especially to note the persistence of this grass. It is possible that under heavy grazing it may be gradually replaced by local Kikuyu and Star grasses growing next to it.

Fertilizer Trial on Brachiaria dictyoneura

This was part of a proposed trial to try to improve the seeding qualities of this grass, which are notoriously bad at Kabete, by the application of nitrogen, phosphates and potash early in the growing season, to be followed, together or separately, by various spraying treatments with insecticides, at different stages of flower growth. The site of the trials was two one-third acre plots established about 10 years previously for grazing and nutritional experiments. One plot was given an overall dressing of 2 cwt. sulphate of ammonia, and 1 cwt. double superphosphate per acre early in the growing season. This plot was to have had the insecticidal spraying treatments; however, the subsequent flowering was so poor, possibly due to the age of the plot, that it was decided to abandon further treatment.

The second plot was divided into eight, and given the following fertilizers, alone and in combination, as in the plan below:—

Sulphate of Ammonia	300 lb. per acre
Double Superphosphate	150 lb. per acre
Muriate of Potash	100 lb. per acre

N 1)	P 2)	K 3)	N.P.K. 4)	Total Area $\frac{1}{3}$ acre
O 5)	N.P. 6)	N.K. 7)	P.K. 8)	

These fertilizers were applied as a top dressing; the growing habit of this grass, a dense leaf cover, makes it almost impossible to do any form of cultivation, unless row planted. As with the first plot the flowering was very poor, and subsequently no seed at all was set. There were visible differences between the sub-plots, and a count of flowering heads by quadrats was made for each sub-plot. Results are given below. Counts in 20 quadrats, a total area of 5 sq. yds., were made in each sub-plot.

Plot Treatment	*Flowering Heads*
NPK	386
N alone	244
NP	155
PK	147
NK	117
Control	82
K alone	79
P alone	61

These fertilizer trials were done in co-operation with the Pasture Research Chemist.

Rhodes Grass Seed Production, Thika

Seed production of the Nzoia strain of Rhodes grass (*Chloris gayana*) was continued on land adjoining the High Level Sisal Research Station, Thika. Rainfall at the station totalled 60.68 in. in 1951 and 27.46 in. in 1952, compared with the previous 12-years' average of 33.60 inches.

From an 80 acre plot, the following yields have been obtained:—

	Harvest—January Short Rains	*Harvest—June–July Long Rains*
1951	1,050 lb.	9,837 lb.
1952	3,697 lb.	4,421 lb.

In preparation for the June–July harvest, a top dressing of 2 cwt. nitrate of soda and 1 cwt. double superphosphate per acre was given in April, 1952, to 35 acres of the above plot. The remaining 45 acres were left untreated. Although by visual observation, the fertilized area appeared to have about twice as many flowering heads as the remainder of the plot, harvesting results were very disappointing due to considerable loss of seed caused mainly by bad harvesting weather, with consequent severe losses by shedding.

The fertilized 35 acres eventually yielded 2,141 lb. seed or 61.2 lb. per acre. The 45 acres which had not been treated produced 2,280 lb. or 50.6 lb. per acre. The whole plot subsequently deteriorated badly, the fertilized area in particular becoming extensively invaded by local indigenous grasses.

Hay

Hay crops were taken from the above plot after the long rains, 1951, and after both rains in 1952, with the following results:—

	Short Rains Tons	*Long Rains Tons*
1951	—	90 (approx.)
1952	97.5	84

Of the 84 tons from the long rains harvest, 1952, 38.2 tons or 0.82 tons per acre were obtained from the unfertilized area, and 45.8 tons or 1.31 tons per acre from the fertilized portion.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (HORTICULTURE), 1952

Meteorological Figures for 1952, for the Molo, Jacaranda and Matuga Horticultural Stations

MOLO

MONTH	Rainfall	Sunshine	Temperature Mean monthly
	inches	*hours*	°F
January	0·32	297·8	56·60
February	1·30	261·4	57·80
March	0·33	262·3	59·40
April	9·57	211·3	59·20
May	5·85	210·0	58·30
June	1·20	263·1	54·08
July	8·21	199·0	55·33
August	7·83	173·3	54·80
September	3·67	225·9	55·81
October	2·15	241·5	56·50
November	0·91	223·7	55·50
December	1·05	267·0	56·43
TOTAL	42·39	2,836·3	56·60

MONTHLY RAINFALL AT JACARANDA

MONTH	*Inches*
January	0·05
February	0·42
March	1·50
April	15·98
May	8·33
June	0·12
July	0·54
August	0·89
September	1·45
October	2·35
November	5·23
December	1·02
TOTAL	37·88

MONTHLY RAINFALL AT MATUGA

MONTH	*Inches*
January	0·04
February	0·58
March	1·46
April	1·59
May	6·59
June	3·36
July	0·63
August	1·44
September	2·08
October	1·86
November	5·16
December	0·24
TOTAL	25·03

At Jacaranda the long rains totalled 25.81 inches and the short rains 10.05 inches. The greatest precipitation in any one day was 6.50 inches on 2t7h April.

At Matuga rainfall was much lower than usual, the long rains being especially poor following an exceptionally long, hot spell.

Tree Fruits

Deciduous

Molo Horticultural Station

Armillaria and Other Diseases.—The loss of trees through Armillaria root rot in Block A appears to be on the increase. Careful examination of the rootstocks just below soil level reveals that many other trees are superficially attacked. Shallow basins have been dug round the trunk of each tree in order to expose the ends of the main roots and create drier conditions where the fungus is less likely to thrive. The object is to prevent trees being completely girdled by the fungus.

The disease situation in Block A is now such that the loss of the majority of the trees during the next few years is a definite possibility. It is intended to start planting Blocks B and C in 1953 to replace as much as possible of the threatened material in Block A.

The tree nursery is also fairly heavily infected with Armillaria and Rosellinia root rot, and Crown Gall. A new nursery will be opened up and the old one planted with annual crops.

Almonds.—Almonds have been under trial at Molo since 1946. Many trees have died as a result of root rot, Crown Gall and Gummosis. The crops harvested have been negligible. It is considered that the Molo climate is unsuited to almonds and it is proposed not to undertake any further work on them. The remaining trees will be left for observation purposes.

Cider Apples.—The growth of most of the cider apple varieties has been disappointingly slow so far. It is likely that some varieties have too great a chilling requirement to be grown successfully in the Kenya Highlands.

Apple Rootstocks.—The apple rootstocks MM 107 and 108 are still the most promising of those under trial and it was considered that a few of these stocks might now be issued to nurserymen. Permission to issue the stocks has, however, been withheld by East Malling Research Station as virus tests have not yet been completed. A further consignment of rootstocks from East Malling arrived at Molo early in the year.

It is considered that the laying down of a statistical trial on apple rootstocks should be delayed, because some of the stocks which are most promising at East Malling were only received here for trial this year. These will have to be multiplied before sufficient material is available for a trial. The amount of information available on suitable scion varieties for a rootstock trial is also limited at present. As the yield from rootstock stool beds is disappointingly low, layer beds for the vegetative propagation of rootstocks have been reverted to in the nursery.

Observational trials on apple rootstocks planted in 1947 in some cases show considerable variation in vigour between individual trees of the same stock scion combination. These differences may be due to superficial infections of Armillaria Root Rot, to Crown Gall or to local variations in soil fertility.

Prolonged dormancy.—It was observed at Molo, October–December, 1952, that deciduous fruit trees in many cases showed more symptoms of prolonged dormancy than normal. The increase in symptoms was such that the growth and

cropping of many trees was seriously affected. An examination of the meteorological figures reveals that there was no increase in mean temperature for the winter months of 1952, the figures for this and the two previous years being as follows:—

	1950	*1951*	*1952*
	°F.	*°F.*	*°F.*
June	56.3	54.08	55.6
July	53.7	54.33	54.2
August ..	56.6	54.8	54.4
Mean ..	55.3	54.73	54.73

The number of hours of sunshine recorded during the winter months of these three years, however, shows a significant difference which probably accounts for the increased symptoms of prolonged dormancy in the 1952 growing season. The figures are as follows:—

	1950	*1951*	*1952*
	hrs.	*hrs.*	*hrs.*
June ..	173.3	190.0	163.1
July ..	112.8	184.2	199.0
August ..	142.2	120.4	173.3
Total ..	428.3	494.6	535.4

In clear sunlight the temperature of the trees themselves rises higher than the temperature of the surrounding air, whereas in cloudy weather this is not the case. The figures indicate that in the Kenya Highlands, mean monthly screen temperatures, or the summation of the number of hours below a certain temperature, do not provide a reliable forecast of prolonged dormancy and thus of the succeeding deciduous crop. It is suggested that mean temperature figures and total hours of sunlight considered together, would enable reasonably accurate forecasts to be made.

At Kabazi Estate, Kiambu, altitude 5,700 ft., the prolonged dormancy trial which was commenced during October 1950 continues. Over a two-year period, the lime-washed trees remain superior, showing 52 per cent freedom. The oil-sprayed trees show 30 per cent freedom, with the untreated controls showing 24 per cent freedom.

"Bitter pit" of Apples.—The incidence of "Bitter Pit" on apples appeared to be slightly less on the 1952–53 crop than during the previous season. This may be due partly to the increasing age of the trees and also to the fact that the trees were not manured in April, 1952. Certain varieties, such as Gravenstein, Blenheim Orange and King of Tomkins County, are very susceptible to "Bitter Pit", whilst others, for example Sharp's Early and Sherwen's Abundance, are highly resistant.

Plums.—The 1952–53 plum crop at Molo was poor generally when compared with the previous season. The reasons for this were dry weather during the period when the fruit was maturing, and a very poor breaking of dormancy, the probable cause of which has been described in the section on Prolonged Dormancy. In spite of the increasing age of the trees, which should have given an increased crop, nearly all trees showed a very considerable decrease. Some varieties, Shiro for example, had a very light crop and the previous season's growth remained dormant throughout the season. Other varieties, of the Methley type, carried a relatively heavy crop but, owing to shortage of soil moisture, the fruit was small in size. Little or no fruit was harvested from late varieties such as October Purple and Beckie Smith.

Peaches.—The peach crop failed almost completely. The fruit failed to ripen properly owing to the prevailing dry conditions. The crop was heavily attacked by birds, as is usually the case in a dry season.

Fruit Tree Borers.—Borers have done considerable damage to lemon and almond trees in Block A. The borer concerned has been identified as *Paraphosphorus hololeucus.* The larva of this insect is a white grub which makes longitudinal borings of considerable length in the branches of fruit trees. Mechanical collapse of the branches usually follows.

Nutrition.—Urea as a foliage spray, applied at the petal fall stage with the object of decreasing excessive drop of young fruitlets, has been tried out this season.

Trials were carried out at Molo Horticultural Station, D. H. Pell-Smith's, Molo, and Simpson and Benson's, Molo. Rainfall during the experiment was sub-normal but it is unlikely that this has influenced the result. Trials were carried out on quinces, cherries and Santa Rosa plums. One or two applications of a 2 per cent solution of Urea, to which was added 1 lb. soft soap as a spreader, was sprayed on to the leaves of the treated trees.

Quite serious leaf scorch was observed on all treated trees a few days after spraying. The spray had no effect in decreasing fruitlet drop on quinces and Santa Rosa plums. Results with cherries were also negative.

Sub-tropical

Matuga Horticultural Station

Citrus Rootstock Trials.—Seed has been sown of the three varieties of stock to be worked on, i.e. rough lemon, sweet orange and *Poncirus trifoliata.* The last has been obtained from Nelspruit, South Africa and Sydney, Australia, the latter supply proving the more satisfactory. A further quantity of each variety will have to be sown before there are anywhere near enough stocks to produce sufficient good quality budded trees for the trial.

Mother Orchard.—All trees have grown well during the year in spite of some pest attack. Numbers of most varieties have been made up (six of each variety) by planting trees from the nursery, and only a few gaps still remain.

Makuti windbreaks were maintained around each of the trees during the six months of the S.E. monsoon, when winds were strong, but in spite of the breaks trees suffered somewhat.

Some 20 tons of cattle manure were imported during the year, most of which was applied to the orchard. Part of the orchard was then sown with the green manure crop sunhemp, but as it could not be afforded sufficient irrigation in a very dry year it was not very successful. This area was used for small vegetable plots between the tree basins, from November onwards.

All older trees of the mother orchard were given an application of sulphate of ammonia during November, at the rate of 3 lb. per tree. Most were flowering, if they were not already bearing fruit, by the end of the year. Interplanting of trees with Hawaiian pawpaws was continued in the three top terraces of the mother garden.

Records of all trees were commenced, with annual growth measurements taken for the first time at the end of the year.

Seedling Selection.—Growers of old seedling orange trees were visited at the time of crop maturity with a view to selecting trees for seed, for production of seedling trees in the nursery and for trying as a root stock. The seed from all the fruit of a selected tree at Junju was sown in November and gave satisfactory germination.

Other Tree Fruits

Varietal Orchard.—A few seedlings each of rambutan bread-fruit, bullocks heart, durian, jakfruit, carambola were planted out during the year. The bread-fruit trees have made exceptional headway, while other seedlings remain poor. Land between the seedling trees has been used for rough lemon seed beds this year.

Mangoes.—Due to poor rains, some Ngowe and Boribo mango seedlings offered for sale were not taken up. The seedlings were large for transplanting, being over a year old. They were sent out bare root. The losses reported by customers varied, some losing many, others very few.

Local varieties are being listed, the Malindi area being one of the best for studying mangoes. A collection of better varieties is to be made at Matuga. A few fruits of each of the varieties Ngowe, Boribo, Kitovu and Zafarani were sent to Tanganyika Packers for canning trial.

Marcotting.—Although marcotts on the Litchi and apple mango trees were made earlier in the year in a Malindi orchard, it was not until the end of the year that trees were in a better condition for this work. Alkathene tubular film was then used, but no success has been experienced yet and Seradix will be tried to stimulate root production.

Chikus. (Achras sapota).—These are very popular among the Asian population and there is a continuous demand for them. An endeavour is being made therefore to propagate the tree at Matuga. Seed seems most satisfactory, though the Asian growers insist on marcotting and I have had several requests to "graft" their trees as they call it.

Pawpaw.—The Hawaiian pawpaws at Matuga cropped for the first time, bearing heavily during April, May and June. Not all trees were the true monœcious Hawaiian, and seed was not selected from those that were not.

Seed from two superior trees was sown at stake in the mother orchard. Further selection will follow when these come into bearing. A few seedlings of two strains of Solo pawpaw have also been planted among the citrus trees.

Banana.—A variety trial at Jacaranda has been abandoned because of unsuitability of the site, which was on a river bank and subsequently subjected to flooding during heavy rains, with subsequent waterlogging. A replanting position has been chosen on a bench terrace where the varieties have been split, half to be irrigated and the other half unirrigated.

At Matuga, a classification and naming of coastal-grown bananas is being attempted, with particular reference to the susceptability of varieties to Panama disease, and their popularity among the local people. Several varieties are established in the nursery mainly as windbreaks and a collection of varieties is being made at the Training School on the Station.

Giant Granadilla (Passiflora quadrangularis).—The vines at Matuga have done well during the year, supported by cashew nut trees. Without the aid of hand pollination, as was once thought necessary, many fruits have set, with the maximum in October–November. Demand for seed is low as the fruit is not yet known.

Coconut.—Some 2,000 seedlings which were not sold during the planting season were retained in the nursery at Matuga for sale in 1953. As this batch of seed was not planted under irrigation, the germination rate was low and very irregular. A new coconut nursery site was selected and the area laid out under irrigation towards the end of the year.

Pests of Tree Fruits at Matuga

Red Spider (*Paratetranychers* sp.).—This was particularly bad on citrus (as well as mango, cashew nut, many ornamental shrubs and trees and herbaceous plants including vegetables) during the exceptionally hot and long dry season experienced in the first half of the year. Two entomologists from the Scott Agricultural Laboratories, visited the nursery in June in this connexion, at a time when the infestation was much reduced, following the advent of cooler weather and some rain.

Two oil sprayings in the previous year had given only incomplete control. A far more rigid spraying programme has, therefore, been adhered to since the infestation reached its climax in April. Three sprayings at 10–14 days intervals with Alboleum spray oil are given now whenever spraying is necessary, if spraying equipment permits.

Thrips.—Owing to the unavailability of sulphur sprays, thrips has been left uncontrolled. The pest has attacked citrus trees in the nursery and fruits ripening on older trees. D.D.T. has not been used against it for fear of destroying the ladybirds that help considerably in controlling red spider.

Aphids. (*Toxoptera aurantii*), have been troublesome during growth flush periods. They were particularly bad during October and November. Nicotine and tobacco sprays had been unobtainable for many months; a BHC preparation was resorted to. Agrocide Wettable Powder is not recommended, being phytotoxic while not satisfactorily effective against aphids. The fungicide "Perenox" was found to kill the aphids very successfully.

Orange Dog Butterfly (*Papilio demodocus*).—The leaf-eating larvæ have been active throughout the year. Control has been fairly satisfactory by hand-picking of larvæ.

Soft Green Scale (*Coccus hesperidum*).—This has been bad in the nursery and along the coast on isolated trees. In the nursery wherever a tree among rows or in the orchard is observed to have scale attack, it has been marked and spot sprayed, three sprayings with Alboleum at 10-day intervals giving perfect control. Although many trees were infested during the earlier months, the nursery was free of this scale by the end of the year. The scale is commonly found on budded citrus along the coast, and growers are advised on control wherever this pest is observed.

Scale (*Pseudoaonidia trilobiliformis*).—This is of little consequence. It is found on many trees along the coast, other than citrus, but no bad infestation has been observed. Alboleum spray oil gives control.

Scale (*Chrysomphalus ficus*).—This is not very common and I have only observed it on citrus seedling trees.

Ferrisiana Virgata is common on citrus as well as many other trees, shrubs and herbaceous plants of the Coast. It seems to be of no serious consequence, unless an infestation builds up on small seedlings. It is controlled by Alboleum spray oil.

Weevils (? *Systatus* sp.).—This is a foliage-eating weevil that will reduce the leaf surface quite considerably at times. It has been controlled fairly well throughout the year by hand-picking and has been of less trouble since the bark was removed from all stakes among budded rows.

Mealie Bug (*Pseudococcus* sp.) is absent from Matuga, but bad in the Malindi area on citrus and mango trees, where it is hard to persuade growers to do anything about it.

White Fly (*Aleurodidæ*), present on all citrus along the coast, is not of much consequence. Alboleum spraying can be used against it.

Pineapples

Fertilizer Trial, Matuga.—A small trial to determine the most suitable rate of application of sulphate of ammonia to pineapple plants was begun at Matuga in early November, 1951.

The area had been planted up some nine months earlier, on the three-row system. Randomized blocks were used with six replications. Treatments were ammonium sulphate applications at the following rates:—

1 cwt. per acre, later increased to 4 cwt. in two applications.
2 cwt. per acre.
3 cwt. per acre.
4 cwt. per acre, later increased to 6 cwt. in two applications.
Control.

Observations showed a marked difference between plots, the higher rate plots being of larger, healthier, darker green plants. These plots were fruiting earlier and giving large fruit, very sweet and juicy, but showing flesh breakdown.

Harvesting of fruit commenced in mid-December and continued a couple of months into the new year.

Zinc deficiency.—Most coastal pineapple plants show mottle leaf to some extent, a symptom of zinc deficiency. A block of pines with mottle leaf was sprayed with zinc sulphate solution, two applications being given at a month's interval. While there was no striking change, the mottle was seen to have decreased to some extent when compared with non-treated blocks.

A branch of a citrus tree showing leaf mottle was also sprayed, with disappearance of the mottle from this branch while other branches remained mottled.

Fertilizer and Mulching Trial, Kilifi.—The experiment was laid down at Sokoke Plantations, Kilifi in March, and is planted on a light reddish, sandy soil at an altitude of approximately 400 ft. The object of the experiment is to ascertain the effects of nitrogen, potash and phosphate fertilizers, and mulching, on pineapples grown both under coconut shade and in the open. Effects will be studied throughout the cropping cycle with particular reference to the quality of fruit for canning. The treatments are as follows:—

(1) N. Nitrogen, as sulphate of ammonia, at the rate of 121 lb. per 1,000 plants, divided into three applications.

(2) P. Phosphate, as triple superphosphate, at the rate of 18 lb. per 1,000 plants, divided into two applications.

(3) K. Potash, as muriate of potash, at the rate of 21 lb. per 1,000 plants, divided into two applications.

(4) M. Mulch, of old pineapple leaves.

Results.—To date observations have been made at monthly intervals. All plants have suffered from lack of moisture this year, following the failure of the long rains. Experimental plots *in the open* remain poor with many losses, and response to fertilizer was negligible until early October when a slightly darker green was seen on N plots on healthier plants. By early December there was a fair response but nothing conclusive, other than the noticeably dark plants of plots receiving N, alone or in combination with other factors. Response to N is only among healthy plants. M generally gives a healthier plot than those without mulch. Little headway had been made by early December.

Under Shade.—General appearance spectacular by early December, each plot appearing uniform, each with its own shade of green.

Some set-back was experienced during July due to burning of leaves, in some cases right through to the crown, as little rain followed fertilizer applications. Early August showed response to N, all plots having received this treatment being a darker green. Effects of P and K began to be observed in early September, P giving a very vivid green and "full" plant, K resulting in pale green–yellow foliage. This effect was further emphasized by early December, with M generally giving a healthier plot. The healthiest plot of the experiment is an MNP under shade. Increase in diameter of shade plants is from 8–18 in. in July to up to 38 in. early December.

Growth among plots of all shade plants has been fairly steady and noticeable since July. The constrast between under shade and in the open trials is very noticeable, the former with satisfactory response, the latter with only slight response. The part of the experiment in the open was abandoned in mid-December.

Rongai Trial.—An observational trial with the object of finding out whether pineapples could be grown successfully in the Rongai area was laid down at the Rongai Experimental Plots in July. Soil light volcanic loam, altitude 6,100 ft. Yield figures will be taken and the effect of a grass mulch studied.

Four thousand rooted pineapple suckers of the Smooth Cayenne variety were obtained from H. M. Bowker, Esq., Kitale, as planting material for this trial. The plot had been ploughed two months previous to planting but was considered too shallow and was therefore dug by hand in parts.

Planting commenced on 17th July and finished on 24th July. Planting methods used were two-row beds, 3 ft. apart, rows 2 ft. apart in the bed and spacing in the row 1 ft. Rain fell during the planting period. The plot was divided into four fairly equal plots of which two were mulched and two left unmulched as control.

The plot was visited twice, on 24th October and 22nd December. Establishment of the plants is almost 100 per cent but they looked rather droughted at the last visit. Up to date no difference between the mulched and unmulched plots has been observed. Very little growth has been made to date, which is consistent with the rainfall since the trial was planted (13.60 in.)

Propagation Trial, Jacaranda.—Following up the work reported in the 1951 annual report, a further trial has been carried out to determine the best type of material to use for propagation by the stem disc technique and whether any such material would prove to be superior to propagation by the fruit top section method.

As results from a previous stem disc trial planted in open beds showed little promise, it was decided to plant the present trial in shaded nursery beds. The top sections would remain in open unshaded beds. The stem disc material used consisted of mature and immature stems which were cut up into discs ranging from ¼ in. to 1 in. in thickness. Both types of material were treated as a nursery crop and watered whenever necessary.

RESULTS AFTER EIGHT MONTHS

DAYS	% Rooted Mature		Stem Discs Immature		Fruit Top Sections (Eight Sections per Top)
	1 in.	¼ in.	1 in.	¼ in.	
100	50	15	38	12	58
150	50	25	38	—	88
240	50	25	38	—	92

As all the remaining fruit top sections are dead, the figure shown represents maximum rooting. The tops are not only very much superior in rooting but in vigour as well, having made twice as much growth as the shoots produced from the stem discs.

Hormones.—A miniature trial was commenced in January to study the effect of hormones on flowering. Seven immature plants of Smooth Cayenne were used in each treatment. The rate of hormone application per plant was one cupful poured into the heart leaves. The hormones used were 2–4 : D, Acetylene acid and Hortomone A, the last-named being used in a range of concentrations. Results were as follows: —

Treatments	Concentrations used in Water	Date Treated	Flowering Commenced	Harvesting Commenced	Fruiting Period	% Plants Fruited
					Mths.	
Control ...	—	11–1–52	3–11–52	Awaited	—	—
Hortomone A	0·25 c.c. 500 c.c.	11–1–52	12–3–52	11–9–52	1	71·4
Hortomone A	—	11–1–52	12–3–52	11–9–52	1	85·7
Hortomone A	0·75 c.c. 500 c.c.	11–1–52	12–3–52	11–9–52	1	100·0
Hortomone A	1·00 c.c. 500 c.c.	11–1–52	12–3–52	11–9–52	—	—
Hortomone A	2 c.c.: 3 gal.	11–1–52	12–3–52	11–9–52	2	85·7
2–4D	—	11–1–52	12–3–52	11–9–52	—	—
Acetylene acid	1·5 oz.: 3 gal. (Carbide)	11–1–52	29–5–52	3–10–52	1	14·2

Mature "Queen" type plants which have never produced flowers have been induced to flower by the use of hormones but the resultant fruits have been small and worthless. Queen pineapple plants though vigorous, even more so than Smooth Cayenne, do not appear to be suitable for this area.

Ruiru–Thika Area

Fertilizer Trials.—The trial commenced at Karimaini Estate, Thika, in December, 1951, received the final fertilizer treatment during September in the form of Sulphate of Iron. The treatments used in the trial were as follows:—

Magnesium Sulphate at 2 per cent by weight at monthly intervals over a period of six months. *Sulphate of Ammonia* at 2,000 lb. per acre at bi-monthly intervals over a period of eight months, applied to the base leaves. *Ethylene Dibromide.* A single application was made as a soil fumigant in a concentration of 10 per cent in Diesel oil.

Interim Results.—The response to Sulphate of Ammonia was observed following the first application representing 500 lb. per acre, colour improvement being intensified until the fourth application when a scorched effect was noticed on the leaves. As further applications were withheld, the malady did not develop and subsequently disappeared. None of the other treatments, except when used with Sulphate of Ammonia, has shown any marked improvement.

Colour improvements on plants treated with Sulphate of Ammonia are so marked that they stand out clearly from some distance. More recently, vigour superiority in plants receiving nitrogen is also becoming noticeable. During November, 1952, a single Ethylene Dibromide treated plot showed symptoms of chlorosis and by December further such plots developed chlorosis. The chlorosis was first observed five months after the Ethylene Dibromide application. Chlorosis, however, has not yet been observed where Ethylene Dibromide has been used with Sulphate of Ammonia. A further trial designed to study the effect of Nitrate of Soda on pineapples was commenced at the same estate during July, 1952. Nitrate of Soda was applied in quantities ranging from 500 lb. to 1,000 lb. per acre in a single application but no response whatever has been recorded even though applications have reached as much as 2,500 lb. per acre.

A similar trial is also in progress at Sisal, Ltd., Makuyu, using Nitrate of Soda alone and in conjunction with Sulphate of Iron and Magnesium. Nitrate has been applied both in crystal form and in solution, using concentrations of 2½ per cent and 5 per cent. During dry, hot weather concentrations of 5 per cent tend to cause severe scorching of the foliage.

Applications have been made direct to the base leaves and also to the soil followed by watering equivalent to 1 in. of rainfall per acre but no response whatever has been observed.

Berry Fruits

Strawberry Variety Trials.—The variety Melba was planted at Jacaranda during April, 1951. Rainfall during the one-year period under review was 48.57 in. but two irrigations representing 4 in. were made during January and February, 1952, to prolong the fruiting period. Harvesting commenced six months after planting and continued for five months. Without irrigation, the harvesting period would have been shortened by two months with considerable loss in yield. The yield, which is based on a 2 ft. by 2 ft. spacing, was 4,083 lb. per acre over a one-year period. Without irrigation the yield would have been in the region of 2,892 lb. per acre.

Following trials at Molo, the strawberry varieties Cambridge 448, now named "Cambridge Pine", and Cambridge 449 are now recommended to growers for local planting. These varieties combine resistance to Strawberry Leaf Spot, with reasonable yields of fruit which has good market qualities. Cambridge Pine usually bears somewhat larger fruit than Cambridge 449. Ripe fruit of both varieties has been railed successfully from Molo to the trade in Nairobi.

The following strawberry varieties have failed in trials at Molo and are not recommended for local planting:—

Early Cambridge.
Madame Lefebvre.
Auchincruive Climax.
Oberschlesien.
Huxley.
Sir Joseph Paxton.

A strawberry variety, having an excellent flavour and said to have been imported into Tanganyika by the Germans, was obtained from Lushoto and is now under trial at Molo.

Protection of Strawberries from Birds.—Individual wire netting cages for each plant have been used at Molo for about three years to protect strawberries against birds. The cages are made from 3 ft. squares of wire netting, cut diagonally from each corner and bent up into a dome shape. This is much the cheapest form of cage, it does not interfere with fruit picking and appears to have an indefinite life. It gives complete protection against birds.

Youngberries.—The area planted with Youngberries has been very considerably extended in order to obtain reliable yield figures and to provide material for future trials.

In the second half of the year many of the Youngberries started to show symptoms which were not inconsistent with virus infection. The leaves became very much dwarfed and curled, and the affected plants failed to mature any fruit. These symptoms have now disappeared and it is thought that they were probably due to unfavourable weather conditions.

Merton Thornless Blackberry.—The plants have made good growth but have failed to produce a single flower in the three years they have been under trial. It seems likely that failure to produce flowers is due either to insufficient winter chilling or to too short a day length.

Unnamed Blackberry ex Border River Nurseries.—The plants made good growth and flowered well. The fruits either failed to set or were very much malformed. The malformation was due to only a few drupels maturing in each fruit. This variety is considered unsuitable for the Highlands.

Breeding

A cross has been made between *Rubus Volkensii* as male parent and Youngberry as female parent. The number of crosses made was 25. The number of seeds set from all crosses was 16. "Alkathene" bags were used for isolating the female flowers these quickly fill up with water transpired from the plant parts enclosed, unless the bags are perforated.

Cape Gooseberry.—A trial was commenced at Jacaranda on 6th February, 1951. First year yields are now available.

Rainfall for a one-year period from the commencement of the trial was 34.73 in. The trial is an unirrigated one. The trial area is on a bench terrace and has not been previously cropped. Because of the movement of soil by terracing, fertility is considered low on the back half of the terrace but to date no fertilizers have been added. The cultural treatment is to cut back plants after fruiting, the prunings being retained and used as a light mulch. The planting distance is 4 ft. by 4 ft. Harvesting was commenced six months after sowing and continued for seven months. The yield for the first year was 5,272 lb. per acre.

Vegetables

Tomato.—A 13-variety trial was sown at Jacaranda on 21st July, 1951, and was concluded on 11th January, 1952. Rainfall during the trial period totalled 23.77 in. and no additional water by irrigation was required. Seeds were sown in nursery beds and then transplanted at intervals of 6 in. in composted beds. When the seedlings had reached a height of about 6 in. they were transplanted to the field.

The trial area, which is being constantly cropped with vegetables, received an application of compost at the rate of 12 tons per acre before planting the tomatoes. The layout consisted of 12 blocks, each of four plots, enabling each variety to be randomized four times. Plots were split, half of each plot containing pruned, single cordon staked plants: the other half containing unpruned unstaked plants. The planting distance of both treatments was 4 ft. by 4 ft. Harvesting was commenced 106 days after sowing. The cropping period being 60 days. Yields, which represent marketable fruits only, were as follows:—

Variety	Pruned			Unpruned		
	Tons	lb.	No. of Fruits per lb.	Tons	lb.	No. of Fruits per lb.
Beauty	2	1,472	3·6	4	1,580	3·8
Earliana	1	1,160	4·0	3	592	4·5
Ailsa Craig	2	2,017	3·9	3	2,010	4·5
John Baer	2	1,985	4·4	5	195	4·8
Marvel	2	1,092	3·5	3	423	4·1
Burwood Prize	2	981	3·8	4	1,389	4·9
Marglobe	2	1,309	3·7	2	1,057	3·9
Break of Day	3	1,273	5·2	7	316	6·6
Bonny Best	2	1,303	4·8	5	1,890	5·4
Gosse Lisse	3	768	3·5	5	1,028	4·0
Best of All	2	1,986	6·2	9	625	6·3
San Marzano	2	1,811	10·7	7	1,842	11·1
Prosperity	5	937	6·3	8	1,641	8·0

An observational trial was planted at Molo with the semi-wild tomato which occurs all along the East African coast. The tomato has proved to be more cold resistant than any other variety tried at Molo and also appears to be highly resistant to Early Blight. Laboratory tests on blight resistance in this variety are now being carried out by the Senior Plant Pathologist. Seed has been sent to the United States Department of Agriculture Research Centre at Beltsville, Maryland, for virus resistance tests.

The fruit of this tomato type is small, approximately $\frac{3}{4}$ in. diameter, but the type appears to have characteristics which will make it valuable for breeding purposes.

Cabbage.—An 11-variety trial was commenced at Jacaranda on 6th March, 1952, and was concluded on 18th July, 1952. Rainfall during the trial period was 25.14 in. A single irrigation representing 1.5 in. was considered necessary to bring the trial to a conclusion. The trial area, which had been previously cropped with tomatoes, received an application of river silt at the rate of 12 tons per acre prior to planting. The layout consisted of 11 blocks, each of four plots, each variety

being replicated four times. Each plot was split to enable the half plots to be dressed with nitrate of soda at the rate of 500 lb. per acre; the application being made 30 days after the cabbage seedlings were planted in the field. Planting distance for all varieties was 2 ft. by 2 ft. Harvesting was commenced 69 days after sowing of the seeds. The cropping period was 39 days. Yields, which represent marketable heads only, were as follows:—

Variety	Treatments							
	With Nitrate of Soda				Without Nitrate of Soda			
	Yield per head		Yield per acre		Yield per head		Yield per acre	
	lb.	*oz.*	*tons*	*lb.*	*lb.*	*oz.*	*tons*	*lb.*
Prize Drumhead	3	0	14	1,310	2	15	14	629
Drumhead Savoy	1	5	6	853	1	2	5	1,051
Early Stonehad	2	6	11	222	2	12	13	827
Christmas Drumhead ..	3	5	17	—	2	12	13	827
Giant Drumhead	2	13	13	1,508	2	12	13	827
Cape Spitskool	1	6	6	1,534	1	13	8	1,612
Brunswick	2	8	11	320	3	1	14	2,055
All Season	2	8	11	326	2	6	11	223
Sugar Loaf Charleston ..	2	2	10	741	1	15	8	929
Wakefield	1	14	9	255	1	12	8	1,130
Surehead	2	5	12	1,344	2	0	9	1,626

Carrot.—A five-variety trial was sown at Jacaranda on 9th April, 1952, and was concluded on 20th September, 1952. Rainfall during the trial totalled 27.23 in. A single irrigation was made towards the end of June which was a very dry month. Had water been available a fourth irrigation would have been made before the conclusion of the trial. The trial area had previously been cropped with tomatoes. Compost was applied at the rate of 10 tons per acre, two months before sowing the carrots. The layout was of single plots. Each plot was split to enable one-half to be thinned to a distance of 2 in. in the rows. The other half being left unthinned. Distance between the rows was 1 ft. Harvesting was carried out in a single operation. The variety Early Horn was harvested at 122 days from date of sowing and the remainder at 159 days. Yields, which represent marketable roots only, were as follows:—

Variety	Thinned			Unthinned		
	Mean weight per root	Yield per acre		Mean weight per root	Yield per per acre	
	oz.	*tons*	*lb.*	*oz.*	*tons*	*lb.*
Early Horn	2·3	11	425	1·9	4	1,390
Danvers Half Long ..	3·5	16	1,860	2·6	18	2,235
Osborne Park Champion	5·3	12	1,603	2·5	12	366
Chantenay	2·9	14	241	3·2	23	790
Nantes	3·0	14	1,333	—	—	—

The yield figures for Nantes unthinned are not available because the crop was mixed with another variety before counting.

Radish.—A two-variety trial was commenced at Jacaranda on 29th October, 1952, and was concluded on 1st December, 1952. Rainfall during the trial was 5.39 in. but a single irrigation before and after the rains totalling 4 in., was necessary to establish and bring the trial to a final conclusion. The trial area had not been under crops before. The soil was considered poor, because of soil movement resulting from bench terracing. An application of compost at the rate of 12 tons per acre was therefore made. Harvesting was commenced 26 days after sowing, there being three harvests in all, covering a period of 23 days. The varieties and yields were as follows:—

Variety	Yield per acre		No of roots per lb.
	tons	*lb.*	
French Breakfast ..	4	1,443	53
Turnip Early Scarlet ..	2	6	86

The variety French Breakfast with 53 roots to the lb. produced an ideal hand bunch for marketing but Early Scarlet with 86 roots to the lb. produced an unwieldy bunch.

Asparagus.—The trial of the Mary Washington variety planted at Molo in 1951 is making good progress. The objects of this trial are to throw light on the growth and cropping cycle at Molo and to find out whether two cutting seasons per year will adversely affect the crowns. Little or nothing is known at present of the production of asparagus in Kenya. Under local climatic conditions there is no clear-cut dormant season. The best season or seasons at which to take the harvest are therefore unknown. This also is likely to vary from district to district. From a study of climatic conditions at Molo it appears that there are two seasons when asparagus is in a dormant or semi-dormant phase, i.e. February/March and August/September. There could therefore be two cutting seasons per year, each following after one of the dormant periods. The present experiment is observational. Two different spacings will be compared. The spacings used in the trial are 4 ft. between rows and 1½ ft. between plants, and 7 ft. between rows and 1 ft. between plants.

Each spacing has been divided into two plots. One plot at each spacing will be harvested once annually (September–October). The other two plots will be harvested twice annually, in April–May and September–October. It is expected that the first short harvesting season will take place in April, 1953, at which time the plants will be 2¾ years old from seed.

Mustard Seed.—English mustard seed was received from Dalgety's, Nairobi, to be grown experimentally as a seed crop. It was sown at the Horticultural Station, Molo, on 26th July, 1952. Spacing rows 15 in. apart, 3 in. within the row, sowing several seeds at each planting position. After an excellent germination during August, the plot flowered profusely at the beginning of November and started setting pods.

An inspection in early January, 1953, revealed that all stages between flowering plants to seed shedding plants could be found. The ripening of the pods was very uneven generally as well as on each individual plant. Heavy damage by birds was observed, which possibly was particularly bad owing to the small size of the plot. Some seed was harvested but most of it was eaten by birds. The trial was completed by the end of January.

Growing mustard as a seed crop does not seem to be an economic proposition as, owing to the extremely uneven ripening of the crop, it entails laborious harvesting spread over a long period. Grown even on a large area, the damage by birds must also be considered as a serious drawback.

Onion.—A trial of the variety Texas Grano received through Dalgety's, Nairobi, was completed by the beginning of April. The yield worked out at 10 tons per acre which is considered excellent. The crop bulbed and matured well and produced well-shaped, mostly medium-sized onions with a yellow skin. A trial of storing this variety (April and May) did not prove successful as all onions started shooting very soon. The Texas Grano Variety is highly recommended where it is not required for keeping.

Texas Grano is a short-day variety which appears well suited to our conditions. It has been very favourably reported on in the Transvaal. Unfortunately there is no seed available at present in Kenya.

Cucumber.—A trial of three varieties with seed received for trial from Messrs. Dalgety's was carried out at Matuga. Small Paris Gherkin was the outstanding variety, yielding an average of 10 lb. per plant, and being immune from Melon Fly attack.

Miscellaneous Crops

Hedge Plants.—Pyracantha angustifolia has proved a very suitable hedge plant at Molo and is recommended for planting in similar climates. The original hedge at Molo was planted in 1947 and is now a dense growth, about 7 ft. high. The plant is very thorny, it has white flowers and orange berries. Propagation is by seed, which should be frozen for six weeks in a refrigerator before sowing.

Fibre Plants

A replicated field scale trial, covering 3.6 acres, was sown in July with five indigenous and one exotic species of fibre plants. Three different row spacings were used for each species. On account of heavy rain much of the seed was washed out soon after sowing, this was followed by dry conditions which resulted in poor growth of the plants. The seed was brought in by native collectors and this resulted in a mixture of species in many plots. The slow initial growth of the plants at a time when weed growth was most active made weed control very difficult.

Except for the exotic mallow, *Malva verticillata,* none of the species made sufficient growth for harvesting during the first season. Only one plot of mallow was of good enough stand to be worth harvesting. The results from this plot were as follows:—

Plot size	400 sq. yd.
Row spacing	21 in.
Date sown	21st July, 1952.
Date harvested	19th January, 1953.
Weight of green stalks	1,217 lb.
Weight of dry stalks	388 lb.
Weight of fibre after retting	24 lb.

Yields Per Acre

Green stalks	14,725 lb.
Dry stalks	4,694 lb.
Fibre	290 lb.

Samples of the fibre were sent to the Scott Agricultural Laboratories. All plots of mallow were heavily damaged by buck.

It has been decided to treat the other five species as perennials. This part of the trial is therefore being continued.

Hops.—Many requests are received from the public for information on the possibilities of growing hops in Kenya. The Plant Quarantine authorities have also received a number of applications for Plant Importation Permits for hop planting

material. There is no doubt that local breweries would welcome the production of hops in East Africa, and the crop should be a profitable one for growers. This Department has discouraged importation of planting material and private trials of hops, because previous trials carried out by the Department at the Plant Breeding Station, Njoro, and at the Horticultural Station, Molo, have been a complete failure. The reason for failure is not known but, in the opinion of the writer, the most likely reason is that the day length in Kenya, being only 12 hours, is too short for the requirements of the hop plant. At the request of East African Breweries, Ltd., a trial to test this theory was carried out at Molo in 1951. The cost of the experiment was borne by East African Breweries, Ltd.

Unrooted hop sets of the "Golden Cluster" Variety, arrived from South Africa on 6th October and were planted out on 8th October in forest loam.

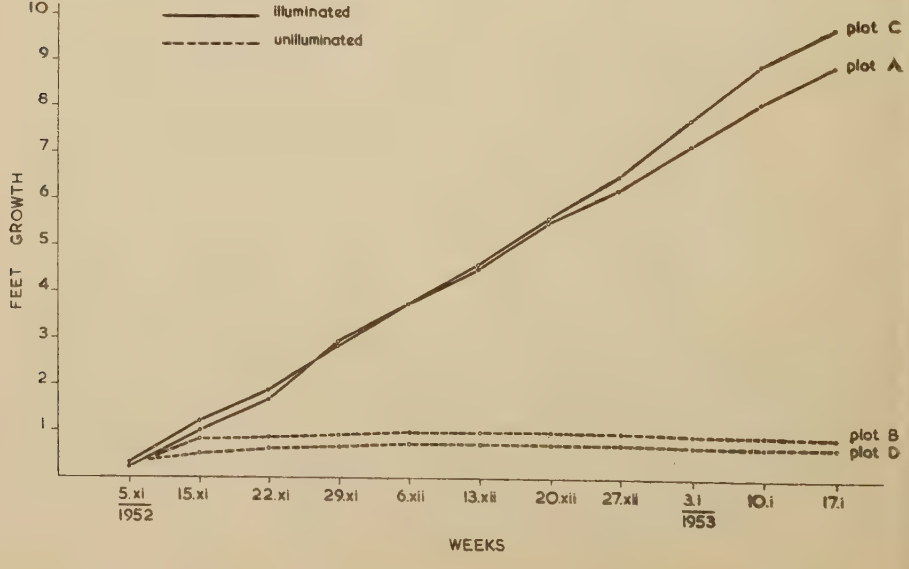
The sets were planted in four beds each containing 12 female and 1 male plant.

I	II	III	IV
15 hours day length	Control	15 hours day length	Control

Plots II and IV are control plots. Plots I and III had the day length increased to approximately 15 hours by artificial illumination. For this purpose one 100 watt tungsten filament lamp mounted in an aluminium reflector was suspended over each plot to give a light intensity of approximately 200 candles per square foot at plant level.

Each plot was mulched with grass. Water was supplied by means of overhead irrigation whenever necessary.

The first shoots appeared above ground on 12th October. Weekly growth measurements were started on 5th November; these are shown in graph form in Fig. 1. For almost one month, up to 5th November, the plants in all plots grew at virtually the same rate. After 5th November, plants in the illuminated plots began to grow much more rapidly and it is considered that the rate of growth was normal for hop plants of this age. Plants in the control plots continued to grow very slowly until 6th December, after which all growth ceased, and on 3rd January the plants had started to decrease in size. On 14th January, flowers were observed on some of the plants in the illuminated plots.



No growth measurements were taken after 17th January because the bines became so long that it was not possible to measure them with any accuracy. Towards the end of January the plants were damaged by a heavy frost.

The mean growth of plants per plot on 17th January was as follows:—

Plot I	Plot II	Plot III	Plot IV
15 hours day length 105·0 inches	Control 9·7 inches	15 hours day length 115·0 inches	Control 7·4 inches

By the time that variation in rate of growth between treatments became apparent there was also a very noticeable difference in the appearance of the foliage. Plants receiving the longer day had large, rather pale green leaves while those receiving a 12-hour day had small, dark green leaves with the veinal serration heavily marked. Later, when plants in the control plots had started to decrease in size, the leaves had become chlorotic with some necrotic patches. An infestation of Red Spider was noted on 10th January but no Red Spider was found on plants in the illuminated plots.

The results show that under Molo temperature conditions a 12-hour day is too short for the normal growth of hops. It must be remembered, however, that the effect of length of day on plants cannot be considered separately from the effect of temperature.

It is known that some "long day" plants which refuse to function normally with a 12-hour day length under certain climatic conditions will do so when grown in a cooler climate. The climate of Molo is cool; the mean monthly temperatures during the experiment were as follows:—

October	56.50° F.
November	55.50° F.
December	56.34° F.
January	57.50° F.

It is possible that mean temperatures in some districts would be slightly lower than at Molo; if, however, temperatures are very much lower, the rate of growth will again be adversely depressed.

A further complication lies in the fact that the hop is a perennial which dies down to the rootstock each year, the whole of the top of the plant being renewed each season. Growth of this type of plant is likely to be influenced by winter chilling. The sets with which the present experiment was carried out were chilled in the South African winter before their arrival here. The effect of the mild Kenya winter on the following season's growth cannot be predicted.

It is obvious from the result recorded above that the hop variety "Golden Cluster" cannot be grown successfully with a day length of 12 hours. This also applies to other varieties tried in the past, which made little or no growth and eventually died. It does not necessarily apply to all hop varieties and it might be possible to find amongst existing commercial varieties some which are tolerant of a short day. Importation of hop material is prohibited from many parts of the world, owing to the risk of introducing disease, and this would limit the number of varieties which could be tried in Kenya.

It is suggested that the problem could best be tackled by growing hops from seed on a large scale and selecting out any seedlings which showed tolerance to a short day. Such seedlings would not necessarily have other desirable characters and would, therefore, have to be further selected. In the opinion of the writer this line of work would probably result in the production of varieties suitable for growing in East Africa. It is, however, unlikely that results would be achieved in less than five years. Whether or not this work is undertaken will depend on the potential importance of hops as a crop in East Africa.

Imported Flower Bulbs.—A trial was made of a considerable number of hyacinth, tulip and narcissus varieties, imported bulbs of which were received from Messrs. Dalgety and "Gardens".

All tulip varieties failed to flower and many of the bulbs rotted in the ground without making any growth.

Hyacinth varieties produced rather indifferent flowers, the flower stalks being very short or almost entirely absent.

Narcissus varieties produced a few good flowers but many had short stalks and blind buds. As Narcissus take some time to get properly established, this part of the trial will be continued.

Toxic Sprays.—A trial in co-operation with the Medical Department, on the possible toxic effects to the operators of spraying deciduous fruit trees with oil emulsions containing D.N.O.C. was carried out at Molo. The results of this trial indicate that at the dilution used (0.15 per cent D.N.O.C.), there is no toxic effect on operators and special clothing is not required, provided reasonable precautions are taken. The danger is in handling the concentrated material before dilution.

Irrigation.—It is not possible to enter here into the pros and cons of the many makes of sprinkler tested at Molo. Advice can, however, always be given on request. Some of the points which have been brought out in trials are as follows: —

(i) High initial cost of some makes which is not justified by their performance.

(ii) Some reaction type sprinklers are unduly influenced by wind.

(iii) Sprinklers with small jets are inclined to blockage unless clean water is used.

(iv) Provision for replacement of working parts, which wear comparatively rapidly, is usually inadequate.

(v) Plain knocker-type sprinklers are generally the most satisfactory.

Marketing, Processing and Storage

Plums.—Owing to adverse weather conditions the Molo plum crop was poor. Almost the whole of the crop was sold to the Njoro Canning Factory for canning. The very small fruit which was not marketable was made into plum wine, which turned out to be quite a drinkable product. This would seem to be a good method for growers to utilize their cull plums.

Apple Storage.—Storage of apples in the underground fruit store at Molo could be undertaken only on a very small scale owing to the high incidence of "Bitter Pit" in the crop. The indications are that apples can be stored successfully under these conditions for two to three months.

Dehydrated Pineapple.—On receipt of information that South African dehydrated pineapple was being successfully marketed in England, it was decided to carry out some local trials in the preparation of this product.

Fresh pineapples were obtained from Thika, in the eating ripe stage. The rind was removed from the fruit and the flesh cut into slices $\frac{3}{4}$ in. in thickness. Each slice was cut into about eight segments. The cut fruit was trayed in single layers in wooden slatted trays and then sulphured for two hours. The trays were then placed in a forced draught pyrethrum dryer and dried at a maximum temperature of 150° F. After 23 hours the fruit was sufficiently dehydrated, moisture content being then about 15 per cent.

The product was of attractive appearance and flavour and on being reconstituted by soaking in water, it almost regained the appearance of fresh pineapple. Samples were kept for seven months, at the end of which period there was no apparent deterioration. The seven-month old product was packed in $\frac{1}{2}$ lb. pressed blocks, wrapped in cellophane. Samples were then sent to the Imperial Institute for a market report. The report received from the trade, through the Imperial Institute, was very favourable; favourable reports have also been received from individuals in the United Kingdom. Larger samples for canning tests were asked for; these will be prepared and despatched next year.

The following are points in favour of dehydrated pineapple as a product for export, compared with canned pineapple:—

(i) Freight is very much reduced owing to decreased weight and bulk.

(ii) No tin plate is required.

(iii) The equipment necessary for dehydration is simple and cheap compared with that required for canning.

(iv) No sugar is used.

T. H. JACKSON,
Agricultural Officer (*Horticulture*).

APPENDIX A

1952 Imports of Fruit Trees Through Kilindini

No. Packages	*Value*	*Increase over 1951*
869	Sh. 101,065	Sh. 30,823

APPENDIX B

1952 Imports of Fresh Fruit Through Kilindini

Kind	Origin	No. Packages	Value	Increase over 1951	Decrease over 1951
			Sh.	*Sh.*	*Sh.*
Apples ..	Australia	403	21,214	21,214	
	U.K.	3,067	102,014	102,014	
	Holland	125	6,850	6,850	
	Italy	16,740	686,713	35,342	
	South Africa ..	750	22,868	22,868	
Grapes ..	South Africa ..	7,585	88,451	—	148,865
	Spain	800	75,689	52,140	
	France	200	4,925	4,925	
Pears ..	South Africa ..	780	6,955	—	25,426
Oranges ..	South Africa ..	4,300	146,198	62,913	
Oranges ..	Zanzibar ..	—		—	—
Bananas ..	Tanganyika ..	15,063	193,985	—	53,060

Total: Sh. 1,355,862

Net Increase: Sh. 24,290.

ANNUAL REPORT OF THE SENIOR CHEMIST (PYRETHRUM), 1952

There is no doubt that there is much to learn about pyrethrum; its responses to weather conditions, its tolerance to weed competition are both very imperfectly understood. During the year under review pyrethrum has behaved strangely. From January onwards production and pyrethrin content dropped rapidly. Production for May, notwithstanding new plantings, almost reached a minimum. Pyrethrin content for April was the lowest average recorded. The reason for this is unknown but the opinion is advanced that during the intense rains of March and April weeding could not be done and so the pyrethrum plants suffered from weed competition. The basis for this opinion is observations made on a field of neglected pyrethrum where weeds and grass overgrew the pyrethrum which then ceased to bloom.

Since May, *vide* Table I, there has been a continuous rise in production culminating with a figure of about 1,000,000 lb. in November and in December, this notwithstanding most disappointing "short rains".

It is of interest to note that of the grading samples almost one-fifth were on behalf of African growers.

Experimentation

The trend of experimentation in 1952 has been somewhat different from previous years. Several experiments in 1951 were abortive owing to heterogeneity in the samples, so much study has been given to sampling technique.

A.—Transit Losses and Preservation of Flowers

An experiment was conducted with miniature bales to ascertain:—

(*a*) The effect of baling pressure.

(*b*) The value of Socophar preservation.

(*c*) The effect of increasing the moisture content by 5 per cent.

Two baling pressures were used, 3,000 and 5,000 lb./sq. in. on the ram.

At each pressure there were four treatments:—

(i) No addition.

(ii) Moisture increased by 5 per cent.

(iii) 0.1 per cent preservative added.

(iv) 0.1 per cent preservative and 5 per cent water added.

The whole was replicated three times, the replications being made at weekly intervals. The bales were stored in a cool room for periods of 1, 2, 3 and 4 months. In addition four samples of loose flowers and one bale of each treatment were assayed at the laying down of each treatment.

In order to overcome the difficulty of sampling, a box was construced, divided into 44 compartments each of the size to hold the quantity required for a miniature bale. The flowers were shovelled over the compartments at random taking the shovelfuls through the pile. The compartments were then distributed at random over the treatments.

That the method of sampling was adequate was shown by an analysis of variance of the preliminary assays. The difference between these, whether baled or unbaled or between all, is insignificant. Thus the results accruing from this experiment are dependable.

The moisture content was augmented by spraying the necessary amount of water from an atomizer over the flowers spread out in a thin layer and then sealing them in a tin with a close-fitting lid to condition for at least two hours.

Assays were done over a period of three months instead of the four as planned, as the baling press broke down and some of the bales were contaminated with oil. It was not till the third month that the effects of treatments became significantly different. The higher baling pressure appeared to be beneficial. Those bales to which water had been added had pyrethrin contents significantly higher ($P=0.05$) than the others. Socophar preservative appeared to be an accelerant of "pyrethrin" loss rather than a preservative.

The experiment indicated that the use of "preservative" was not warranted and that further investigation of the effects of baling pressure and variation of moisture content would be of value. Unfortunately, owing to breakdown of the press, this was not possible but it is hoped to investigate these points in 1953 since a press has been obtained.

B.—Sampling Techniques

It has long been recognized that the sampling of dried flowers is most difficult owing to the shattering of the flower heads in handling. The more dried flowers are mixed the greater the heterogeneity of the mass. Normal quartering does not overcome the difficulty as the loose achenes may lie anywhere. It was therefore considered necessary to make a detailed study of the subject. Obviously the satisfactory technique used for the baling experiment is not applicable to export consignments or to growers' deliveries.

(i) *Export Consignments.*—The normal procedure in export consignments is for continuous grab samples to be taken from the flowers as they flow from the mixing hopper to the weighing hopper to about 4 lb. per bale. The combined samples are then mixed and quartered down to give a 4 lb. sample for analysis. The residue forms the one hundred and twenty-fifth bale of a consignment.

The problem was to find a means of sampling which would give a result within 5 per cent of the true mean. There is no need to detail the procedure but it was found that it is necessary to draw eleven grab samples of 3 lb. each to obtain a true sample.

(ii) *Baled Pyrethrum.*—In baling pyrethrum a certain amount of segregation of the parts of the shattered flowers occurs as the flowers fall into the baling cage, with the result that the bale is striated. If a coring tool is used to obtain samples (and, indeed, it is the only possible implement), and is used in the plane of the striations, most uneven samples can accrue. It is essential that the coring tool be used at right angles to the plane of striation.

A detailed study showed that in drawing a sample from a bale it is necessary to draw 8 cores, 4 from the top and 4 from the bottom, at right angles to the striations.

Recommendations have been made to the Pyrethrum Board embodying these findings but cannot be implemented till more mills are available to deal with the large quantities of flowers.

(iii) *Growers' Deliveries.*—It has long been realized that the method of sampling growers' deliveries by taking a handful from each bag is unsatisfactory. There is segregation in the bag and achenes tend to seep downwards. When the idea of grading by analysis was first adumbrated years ago, a sampling machine was designed but its installation would have required another floor to the baling block. Thus arose the present method of sampling, inadequate but of some value. However, it appeared desirable to develop a better method.

A probe which will permit of samples being drawn through the whole length of the bag has been made. With this tool samples have been drawn from a series of representative deliveries. The variation between bags was determined and then the number of samples that should be drawn from the bulk of samples drawn from the bags by means of the probe was calculated. This study is not yet completed but it appears that 8 are required from the bulk drawn from a lot of 21 bags. This again entails the gristing of a large quantity and until more mills are available the recommendations made to the Pyrethrum Board cannot be put into effect.

C.—Methods of Analysis

(i) The method of assay laid down by the A.O.A.C. in the 7th edition of their publication *Methods of Analysis* differs from that in the 6th edition in that the primary petroleum ether extract is chilled and filtered to remove "waxes". At the request of the Pyrethrum Board a series of comparative assays was made use in both methods.

In all, 27 samples were assayed when it was found that the results by the 7th edition method were appreciably lower than by the 6th edition method, the averages being "pyrethrins I" 4.3 per cent, "pyrethrins II" 4.6 per cent. That the removal of "waxes" insoluble in cold petroleum ether reduces the apparent pyrethrin content was shown by work done 20 years ago.

(ii) Further work has been done on the methods for estimating "pyrethrins I". In the standard A.O.A.C. method, sulphuric acid is used for neutralizing the alkaline solution after saponification of the extract. This precipitates barium sulphate, which, according to the method, has to be filtered off. In the Imperial Institute method hydrochloric acid is used instead of sulphuric acid and so there is no precipitate to be filtered off. The latter method gives results appreciably higher than the A.O.A.C. It has been suggested that chrysanthemic acid is partially absorbed on the barium sulphate precipitate.

A detailed study of both methods has been completed during the year under review. In fact a portion of the chrysanthemic acid is physically held up by a group of organic acids, insoluble in acidulated water. The chrysanthemic acid so retained may be completely recovered by repeated solution of this mixture and reprecipitation followed by filtration. One portion of the insoluble acids is soluble in petroleum ether but has no effect on the Deniges reagent which reacts with chrysanthemic acid. Thus, by the Imperial Institute method, a more correct measure of the "pyrethrins I" is obtained than by the A.O.A.C.

A paper has been preparaed and is under consideration by the A.O.A.C.

D.—Moisture Content of Pyrethrum

During the year there were many comments from American processors on the subject of the determination of the moisture content of pyrethrum flowers. The determination of the moisture content of plant materials is a problem involving many unexpected difficulties. A few of the possble methods will be considered.

Firstly, there is the classical method which consists of heating a weighed quantity of the material in an oven at a specified temperature to constant weight or to the point where the weight begins to increase. Since, when the method was prescribed, most, if not all, laboratories were about sea level the temperature usually employed was 105° C., i.e. 5° C. above the boiling point of water. When Gnadinger and the writer began their collaborative work in 1936 they decided, after a discussion, to employ an empirical method, viz. heating for 5 hours in an oven at the temperature of boiling water at the laboratory, i.e. at Scott Agricultural Laboratories 94.5° C. It was recognized that the loss of weight would include not only moisture but also materials volatile at that temperature, such as essential oils. This method has been our standard ever since.

Later in the history of plant chemistry it was realized that heating for long periods at a temperature of 105° C. could cause decomposition of constituents and thus an incorrect result could accrue. Drying at much lower temperatures in a vacuum oven was adopted. But in really critical work drying *in vacuo* over a strong desiccant to constant weight is recognized as probably the most accurate means. Of course, there is the possibility that volatile constituents may be absorbed on the desiccant. The great fault of this critical method is the time required, often a week or more for a single determination.

Of comparatively recent years the distillation method, which is preferred by the American processors, has been developed. This consists in heating a sample in a solvent insoluble in and lighter than water, condensing the vapour and collecting the mixed distillate in a graduated separating receiver. The method has several advantages: it is quick, requires little attention or labour, and is reasonably accurate; but there are several difficulties: the solvent must be chosen with due care or high distillation temperatures may cause decomposition with the production of water; the material being examined is heavier than the solvents usually employed and so sinks to the bottom of the flask and thus becomes overheated with consequent decomposition.

In view of the many comments, a survey of the determination of moisture in pyrethrum powder was made employing the three methods described above, viz:—

(*a*) The empirical standard method of Scott Agricultural Laboratories.

(*b*) *In vacuo* at air temperature over a strong desiccant.

(*c*) Distillation in toluene.

It was found that there was good comparison existing between results by methods (*a*) and (*b*) but method (*c*) gave results on an average 10 per cent higher. This is not unexpected in view of the fact that toluene boils here about 10° C. higher than does water and furthermore the pyrethrum powder clings to the wall of the distillation flask. Special apparatus for use with entraining liquids heavier than water has been ordered to carry the study further.

Advantage was taken of this work to calibrate Marconi moisture meters, instruments based on electrical conductivity. These instruments will make it possible for moisture determinations to be done on growers' consignments at remote places.

E.—False Pyrethrins

In last year's Annual Report the suggestion was made that some of the new high content strains contained materials of no toxic value but which appeared as pyrethrins in assay, chemical or spectrophotometric. As far as space has permitted work has been continued and it does appear that the suggestion is confirmed.

That such a change can occur in the economy of the pyrethrum plant is borne out by classical researches. The active principle of pyrethrum powder had been a mystery notwithstanding many researches over a period of 50 years. Staudinger and Ruzicka in a research extending over 1910 to 1916, published in 1924, showed that the toxic principles were two esters of an unsaturated keto-alcohol, which they named pyrethrolone, with two acids; one, the ester of the acid which had been named chrysanthemum monocarboxylic acid, was termed pyrethrin I; the other, an ester of the monomethyl ester of a dicarboxylic acid, was termed Pyrethrin II.

This research is recognized as one of the finest in plant chemistry and was instrumental in securing the Nobel prize for the workers. It is therefore noteworthy that there was only one keto-alcohol found. The flowers used were Dalmatian. Some 20 years earlier Haller and La Forge, working on Kenya flowers, isolated a new keto-alcohol which they named cinerolone, this has one carbon atom less in the side chain. It is inconceivable that Staudinger and Ruzicka should have overlooked such a constituent in their material. Is it not more likely that under Kenya conditions a change had occurred in the make-up of the flowers? Such changes do occur when plants are bred under strange conditions.

A purified concentrate was prepared from one of the new high-content strains. On assay it appeared to contain over 100 per cent pyrethrins. The concentrate also polymerized most rapidly. Further investigation was indicated.

Two purified concentrates have been produced, one directly from a petroleum ether concentrate; for the other the petroleum ether was completely removed, the residue taken up in alcohol, the alcoholic solution distilled *in vacuo* and the residue dissolved in petroleum ether for treatment with nitro-methane.

The first concentrate assayed at 92 per cent, the second at 77 per cent. The second concentrate was more mobile than the first and did not polymerize with the great rapidity of the first.

Chromatographic separation on a celite column apparently separated "pyrethrins" I and II but assays of some of the fractions gave strange recoveries of over 100 per cent. Absorption spectra of these fractions did not agree with those of the pyrethrins. With the second concentrate chromatograms were not so clear but it did appear that most of the fractions were "pyrethrins".

It is very likely that upon these results a method of analysis which will differentiate between true and false pyrethrins may be evolved. It is too early to make any definite statements. Much work is needed but a possible line of development is being followed.

Publications

Pyrethrum Drying. V. A. Beckley. "Pyrethrum Post." 1952:3:9.

Acknowledgments

The writer wishes to record his sincere thanks to all members of his staff for their loyal support during the year. Special thanks are due to Mr. Hopkins who, by his overtime, enabled us to complete the amount of work. Thanks are also due to Dr. Webster for help in designing the many sampling experiments.

V. A. BECKLEY,
Senior Chemist (Pyrethrum)

TABLE I

	Weight of Flowers		Per cent Pyrethrins	
	1951	1952	1951	1952
January	290,495	478,626	1·49	1·44
February	186,963	522,963	1·38	1·30
March	81,415	389,294	1·43	1·26
April	43,133	176,763	1·30	1·21
May	40,909	52,753	1·51	1·44
June	214,082	104,480	1·46	1·39
July	456,930	298,601	1·49	1·42
August	568,120	443,763	1·63	1·51
September	544,202	463,322	1·57	1·52
October	526,504	637,022	1·48	1·47
November	606,566	950,395	1·57	1·42
December	653,813	999,515	1·55	1·41
TOTAL	4,214,132	5,517,497		
AVERAGE			1·53	1·41
Number of samples over 2 per cent	16	26		

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (PYRETHRUM), 1952

Meteorological

Rainfall was below average and erratic throughout the greater part of the pyrethrum growing areas during the course of the year and whilst production rose from 4,214,132 lb. of dried flowers in 1951 to 5,517,497 lb. in 1952, the average pyrethrin content ofr the Colony fell from 1.53 per cent in 1951 to 1.41 per cent in 1952. The increased production in 1952 was due to the increased acreage under pyrethrum and the estimated yield per acre of flowers declined somewhat.

On the Experimental Stations the rains started at the beginning of April and were plentiful until the middle of May after which a dry spell lasting until towards the end of June was experienced. Although the rainfall figures for July and August appear normal, distribution was bad, in each month there being a dry spell lasting ten days or more. Conditions for planting were consequently very difficult and some of the later-planted trials had to be artificially watered.

With the exception of Subukia, effective rains stopped towards the end of August or in September with the result that the picking season was cut short and total yields of pyrethrum were considerably lower than during the 1951/52 season. The effect of the short picking season and distribution of rainfall was also reflected in the production of smaller flowers throughout the season.

Total rainfall figures for the Experimental Stations were as follows:—

Ol Joro Orok	7,800 ft.	28.77 in.
Molo	8,300 ft.	42.39 in.
Marindas	9,000 ft.	35.45 in.
Subukia	7,000 ft.	43.10 in.

Detailed meteorological data for the Experimental Stations are appended.

*Experimental Work

Large Rotation Trial

Reference is made to Part II: 2 (*f*) of this Section's Annual Report for 1951 which was circulated to Growers and in which the objects and results to the end of the 1951/52 season of this trial, laid down at Ol Joro Orok between 1947 and 1949, are given.

The trial has the main object of determining the proper place of pyrethrum in a balanced system of rotational farming and is designed to test the following rotations with varying quantities of phosphate and compost—

Continuous Pyrethrum.
Pyrethrum : Cereals.
Pyrethrum : Grass : Grass.
Pyrethrum : Grass.
Pyrethrum : Pyrethrum : Grass.
Pyrethrum : Cereals : Grass.

Each crop remains on the ground for a period of three years.

*Trials reported in Part II: 2 of this Section's Annual Report for 1951 and not included in Part II: 2 of the current Report have been concluded or discontinued.

Preliminary results have indicated that the soil of those plots now under pyrethrum following three years' grass has a better structure and stands at a higher level of general fertility, as determined by chemical and physical analyses, than corresponding plots which have been under continuous pyrethrum. No differences in yield between the Grass : Pyrethrum and Continuous Pyrethrum plots have, however, yet been observed. Furthermore there have been indications that phosphates, in accordance with past experience, increase the yield of pyrethrum in the first year only and that applications of compost have a suspended-action effect which becomes manifest in the third year.

Results for the 1952/53 season do not confirm the preliminary indications in regard to the effect of phosphates and compost. Results to date continue to be statistically insignificant.

Shading Trial

Reference is made to Part II:2 (i) of this Section's Annual Report for 1951 in which the objects and results to the end of the 1951/52 season of this trial, laid down at Molo in 1950, are given. The trial has had the object of determining the effect of shade on the incidence of Bud Disease. The trial has been carried out on Clone 194, there being three treatments—No Shade (Control), 40 per cent Shade and 90 per cent Shade. The shade was erected artificially above the pyrethrum plants.

Results for the 1951/52 season showed clearly that the main effect of dense shade was to decrease flower production, as indicated by the figures given in this Section's Annual Report for 1951.

Results for the 1952/53 season confirm the previous season's findings, the corresponding figures being as follows:—

	No. of healthy flowers	*Total fresh weight of flowers: gms.*	*Mean fresh flower weight: gms.*	*No. of diseased buds*	*Disease rate*
No Shade	5,219	3,079	0.59	154	3.0
40% Shade	5,369	3,060	0.57	164	3.1
90% Shade	2,851	1,568	0.55	113	4.0

(The Disease Rate is the number of diseased buds picked per 100 healthy flowers picked.)

The figures follow those for the previous season very closely except that the mean flower weights are much smaller, due to the erratic rainfall conditions, and so consequently are the total weights of flowers. In neither season does dense shade appear appreciabliy to have increased the incidence of Bud Disease which was low throughout both seasons.

Analysed by X^2, the figures for the 1952/53 season show significant differences in yields and disease rates between No. Shade and 90 per cent Shade and between 40 per cent Shade and 90 per cent Shade.

The trial has been concluded.

Picking/Stripping Trial : 1950

Reference is made to Part I : 5 (*a*) of this Section's Annual Report for 1951.

This non-statistical trial was laid down at Molo in 1950 on a field of 14 x 24. Stripping (defined as the picking of all opened flowers irrespective of their stage of maturity) was carried out at intervals of two and three weeks, the Control consisting of selective picking at two-weekly intervals, i.e. the flowers were picked as near as possible to what has previously been considered the "ideal" stage.

The trial was discontinued at the end of the 1951/52 season. Results for the two seasons of the trial are as follows:—

1950/51

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
Two-weekly picking	596	10.32
Two-weekly stripping	545	9.05
Three-weekly stripping	617	10.89

1951/52

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
Two-weekly picking	941	18.12
Two-weekly stripping	994	18.11
Three-weekly stripping	1,103	20.82

It would appear that for both seasons three-weekly stripping is slightly superior to the other two treatments; in any case it is obvious that there is no advantage to be gained by selective picking.

PICKING/STRIPPING TRIAL : 1951

Reference is made to Part I : 5 (*b*) of this Section's Annual Report for 1951.

This trial was laid down at Molo in 1951 and is similar to the 1950 picking/stripping trial except that four-weekly stripping has been added and the four treatments are carried out on three varieties: 14 x 27, C.47 and Bulk. The trial is, moreover, statistically designed (four randomized blocks each containing three plots for the three varieties; each plot split into four sub-plots for the four treatments).

Results for the two seasons to date of this trial are as follows:—

A. Varieties *1951/52*

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
C.47	1,063	27.20
Bulk	927	17.00
14 x 24	748	15.70

Differences required for statistical significance:

	P=0.05	P=0.01
Dry flowers : lb./acre	± 141	± 213
Pyrethrins : lb./acre	± 3.10	± 4.80

1952/53

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
C.47	1,007	24.48
Bulk	982	16.55
14 x 24	820	16.34

Differences required for statistical significance:

	P=0.05	P=0.01
Dry flowers : lb./acre	INSIG.	INSIG.
Pyrethrins : lb./acre	± 3.95	± 5.99

B. Treatments

1951/52

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
Two-weekly picking	903	19.66
Two-weekly stripping	963	20.82
Three-weekly stripping	952	21.20
Four-weekly stripping	834	18.25

Differences required for statistical significance:

	P=0.05	P=0.01
Dry flowers : lb./acre	± 64	± 86
Pyrethrins : lb./acre	± 1.40	± 2.00

1952/53

	Weight dry flowers: lb. per acre	*Weight pyrethrins: lb. per acre*
Two-weekly picking	910	18.27
Two-weekly stripping	1,021	20.87
Three-weekly stripping	932	19.48
Four-weekly stripping	882	17.89

Differences required for statistical significance:

	P=0.05	P=0.01
Dry flowers : lb./acre	± 98	INSIG.
Pyrethrins : lb./acre	± 1.99	± 2.69

The figures for the picking/stripping treatments covering the two seasons over which this trial has been carried out show conclusively that there is no advantage whatsoever to be gained by selective picking and that, in fact, two-weekly or three-weekly stripping is actually somewhat superior. Moreover there is no interaction between varieties and treatments, in other words two-weekly or three-weekly stripping is still somewhat superior whether it be carried out on 14 x 24, on C.47, or on Bulk.

It can consequently be confidently recommended to the Grower hereafter to strip his flowers at two-weekly or three-weekly intervals and to forego the tiresome practice of two-weekly selective picking which has been the custom in the past. Apart from being a labour-saver in the present difficult times, the picking of all opened flowers irrespective of their stage of maturity would immensely facilitate the perfection of a mechanical picker upon which work is proceeding at the present time.

N.P.K. Fertilizer Trial

Reference is made to Part I : 5 (*c*) of this Section's Annual Report for 1951.

This trial (a 3^3 factorial design with two replications arranged in six blocks of nine plots each) was laid down at Marindas in 1950. This trial combines applications of double superphosphate at planting time at the 50 lb. and 150 lb. per acre levels, of muriate of potash, also at planting time, at the 50 lb. and 100 lb. per acre levels and of sulphate of ammonia at the 200 lb. per acre level applied in the one case at planting time and in the other case spread over the season in several applications. Applications of sulphate of ammonia have been repeated during the course of the second and third seasons.

During the first (1950/51) season an application of 150 lb. per acre of double superphosphate in the planting holes significantly (P=0.01) increased the yield per acre of dry flowers by 39 lb.; from 164 lb. (no phosphate) to 203 lb.

During the second (1951/52) season the effect of the application of 150 lb. per acre of double superphosphate in the planting holes continued and a significant increase (P=0.05) in the yield per acre of dry flowers of 108 lb. was obtained; from 1,289 lb. (no phosphate) to 1,397 lb.

During the third (1952/53) season no significant increase in the yield of dry flowers was obtained as a result of the application of 150 lb. per acre of double superphosphate in the planting holes. The overall increase was thus 147 lb. per acre of dry flowers spread over the first two seasons.

200 lb. per acre of sulphate of ammonia spread over the first season in several applications significantly (P=0.01) decreased the yield per acre of dry flowers by 31 lb.; from 188 lb. (no nitrogen) to 157 lb. This effect was not, however, observed during the second or third seasons despite the fact that the applications of sulphate of ammonia were repeated.

An application of 50 lb. per acre of muriate of potash, applied at planting time, during the second season significantly (P=0.05) increased the pyrethrin content of the flowers but this result was based on two spectrophotometric analyses only and a number of spectrophotometric analyses carried out during the course of the third season has not confirmed the original result.

With regard to the somewhat spectacular effect of double superphosphate during the first two seasons, it should be borne in mind that the soil at Marindas shows a marked deficiency of phosphorus.

The trial has been concluded.

Control of Eelworm Trial

Reference is made to Part I: 5 (*f*) of this Section's Annual Report for 1951.

This observational trial was laid down at Subukia towards the end of the 1948/49 season and was designed to determine the effect on the control of eelworm of applying DD (a Shell product) to land known to have been infested with eelworm in the past. The pyrethrum on this land, showing obvious signs of eelworm attack, was uprooted and the area divided into four plots separated from each other by deep ditches as a protection against lateral movement of the pest. Two plots were treated with DD and two left as Controls.

During the 1949/50 season all plots were planted up with potatoes and at harvest time no sign of eelworm was found on any of the plants. The yield of tubers was slightly less on the plots treated with DD than on the Controls (4.82 and 5.38 tons per acre respectively).

During the 1950/51 season the four plots of the trial were planted up with tomatoes. These made good growth on the whole but it appeared that the tomatoes on the untreated control plots were not quite as vigorous as those on the plots which had been treated with DD. Upon harvesting the tomatoes it became evident that there was a heavy infestation of eelworm in the untreated control plots and only a slight infestation in the plots which had been treated with DD. Suprisingly, however, this was not reflected in the yield of the tomatoes which amounted to approximately seven tons per acre on both the untreated control plots and those which had been treated with DD.

During the 1951/52 season all plots were again put under pyrethrum which was eventually uprooted at the end of the 1952/53 season. Upon examination it was discovered that, after the four seasons of the trial, eelworm infestation was fairly even throughout the two untreated control plots and the two plots which had been treated with DD.

The trial has been concluded.

Bud Disease : Spraying/Dusting Trials

These trials, laid down at Ol' Joro Orok and at Molo during 1952, were intended to determine the effect of spraying and dusting on the control of Bud Disease.

These factorial trials in each case consisted of randomized blocks with split plots and three replications. Treatments were as follows:—

(*a*) Dust with Perelan (dispersible cuprous oxide) versus spray with Bordeaux Mixture.

(*b*) Starting six weeks before the rains versus starting with the rains.

(*c*) Every five days versus every ten days.

(*d*) Top of the plant only versus the whole clump.

The trial was carried out on a field of C.13 at Ol' Joro Orok and on a field of 14 x 24 at Molo. At Ol' Joro Orok Bordeaux Mixture was applied at the rate of approximately 80 gallons per acre, and at Molo at the rate of approximately 200 gallons per acre; it is realized that this latter application is uneconomic but for various reasons it was desired to determine the effect on Bud Disease of Bordeaux Mixture at this level of application.

The results obtained from this trial were largely of a negative nature. Neither at Ol Joro Orok nor at Molo could any effect of Bordeaux Mixture on the control of Bud Disease be observed. At both Ol' Joro Orok and at Molo Perelan dust had a harmful effect on the pyrethrum plants and, by reducing yield, increased the Bud Disease rate. At Ol' Joro Orok there were also indications that dusting every five days was more detrimental than dusting every ten days and that copper, either in the form of dust or spray, reduced the pyrethrin content of the flowers.

The trial has been discontinued.

Bud Disease : Economic Loss (Disbudding) Experiments

These experiments, laid down at Ol' Joro Orok and at Molo during 1952, were intended to determine the loss in yield caused by Bud Disease. The design in each case was a 6 x 6 Latin Square. At both Ol' Joro Orok and at Molo the experiment was carried out on a field of Clone 194.

Treatments consisted of regular disbudding to simulate losses from Bud Disease at the following levels:—

Control (no disbudding).

10 per cent disbudding.

20 per cent disbudding.

30 per cent disbudding.

40 per cent disbudding.

50 per cent disbudding.

Negative results were obtained. Neither at Ol' Joro Orok nor at Molo was any loss in yield observed as a result of the disbudding treatments, even at the 50 per cent level; apparently the pyrethrum plant replaces these artificial losses

It should be borne in mind, however, that these experiments were entirely of a mechanical nature and that they take no account of loss in yield caused by any phyto-toxic effect of *Ramularia bellunensis*. The results obtained are not altogether unexpected since the replacement by the plant of buds artificially removed is common horticultural experience.

The experiments have been discontinued.

Plant-breeding

A total of 1,070 single plant selections were under observation at the Experimental Stations during the 1952/53 season.

Twelve variety trials, in their first to their fourth year stages, were being carried out on the Experimental Stations during the course of the year. The high-performance crosses mentioned in this Section's Annual Report for 1951; Part II: 3, namely C.45 (188 x 194), C.48 (188 x P), C.57 (194 x 486), C.77 (468 x 486), C.79 (468 x P) and Congo 1949 continued to give promising results despite a poor season.

The system of "sugar-beet" line-breeding started at Molo during the 1951/52 season was continued. In this system a number of clones selected for—

(*a*) high altitude; and

(*b*) low altitude,

and within each of these categories—

(*a*) high yield of flowers; and

(*b*) high pyrethrin content,

are crossed one with the other in isolated plots.

During the 1952/53 season the seedlings resulting from the high altitude and low altitude crosses were planted out in isolated plots of about ¼-acre each at Molo and Subukia respectively. Also during the 1952/53 season eleven further isolated plots each containing three or four clones were planted up for the initial stages of the "sugar-beet" breeding seystem.

It is hoped that during the 1954/55 season seed harvested from the isolated plots laid down at Molo and Subukia during the past season will be issued to Growers. Meanwhile testing and selection will be carried out within the existing poly-crosses and line-breeding continued.

During the 1952/53 season a number of new crosses were being made in isolated plots at Ol' Joro Orok and Molo in the normal course of breeding work. The seedlings from those crosses which have produced viable seed will be laid down in Variety Trials during the 1953/54 season.

Areas under seed production during the 1952/53 season were as follows:—

C.47: 5½ acres at Ol' Joro Orok Experimental Station;
C.47: 1 acre at Molo Experimental Station;
C.47: ¾ acre on Mr. Foster's farm at Kaptagat;
C.47: ¼ acre on Mr. Bevan's farm at Subukia;
C.47: ¼ acre on Mr. McLellan's farm at Thomson's Falls;
C.47: ¼ acre on Mr. Levet's farm at Thomson's Falls;
C.43: ¼ acre on Mr. Alexander's farm at Molo;
C.51: 1 acre at Marindas Experimental Station;
1970 Control: Two acres at Molo Experimental Station;
Mixed Crosses: One acre at Marindas Experimental Station.

In addition to the above strains, small quantities of seed of "Ol' Joro Orok Bulk", "Molo Bulk" and "Subukia Bulk" were produced.

Deliveries of seed to the Pyrethrum Board during 1952 amounted to 702 lb. from the experimental stations and 175 lb. from private growers. The amounts delivered for the season would have been much greater had it not been decided towards the end of the 1952/53 season to suspend the issue of seed of C.47 to growers on account of its alleged lack of biological effectiveness.

A considerable number of seedlings from various new crosses produced on the experimental stations was planted out in bulk to provide material for further selections, etc. It is proposed during the 1953/54 season to uproot the $\frac{1}{4}$ acre of C.43 on Mr. Alexander's farm at Molo and to plant up a larger acreage with the material on the Molo Experimental Station.

During the course of the 1952/53 season small observation plots were laid down within a low-altitude plot (6,500 ft.) on Mr. Prentice's farm near Nakuru.

Pests and Diseases

Once again no spectacular outbreaks or infestations were experienced during the course of the season. The usual cases of eelworm, thrips, etc., were experienced but no marked increase in their incidence was observed. The incidence of root-rot was, if anything, less than that of the previous season. The incidence of Bud Disease appeared to be no greater than usual; figures from the experimental stations suggest that it was less. At Ol' Joro Orok the mean Bud Disease rate for the season was 5.1; at Molo the figure was 3.8.

Acknowledgments

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Appreciation is extended to Messrs. Allison, Prentice, Polhill, Pope and Whetham for kindly making land available to the Department for experimental purposes at Subukia, Nakuru, South Kinangop, Londiani and Kipkabus respectively.

Finally the ready assistance and co-operation of the staff of this Section is to be recorded and gratefully acknowledged.

F. H. ORMEROD,
Agricultural Officer (Pyrethrum).

APPENDIX

Meteorological Data

(*a*) *Ol' Joro Orok* (*Altitude* 7,800 *ft.*)

1952	*Mean temp. °F.*	*Rainfall (in.)*
January	56.8	0.09
February	58.5	0.63
March	59.9	0.13
April	60.0	3.54
May	57.1	8.02
June	54.2	1.49
July	54.9	4.92
August	52.1	5.68
September	53.8	0.72
October	55.4	1.80
November	55.9	0.71
December	56.5	1.04
	Mean 56.3	Total 28.77

(*b*) *Molo* (*Altitude* 8,300 *ft.*)

1952	*Mean temp. °F.*	*Rainfall (in.)*	*Sunshine (hr.)*
January	56.6	0.32	297.8
February	57.8	1.30	261.4
March	59.4	0.33	262.3
April	59.2	9.57	211.3
May	58.3	5.85	210.0
June	54.1	1.20	263.1
July	55.3	8.21	199.0
August	54.8	7.83	173.3
September	55.8	3.67	225.9
October	56.5	2.15	241.5
November	55.5	0.91	223.7
December	56.4	1.05	267.0
	Mean 56.6	Total 42.39	2,836.3

(c) *Marindas* (*Altitude* 9,000 *ft.*)

1952	*Mean temp. °F.*	*Rainfall (in.)*
January	54.9	0.00
February	56.4	0.82
March	57.0	1.44
April	57.9	7.59
May	56.7	6.57
June	53.2	2.78
July	53.7	5.81
August	52.8	4.72
September	54.0	2.22
October	54.7	1.70
November	55.2	1.34
December	55.4	0.46
	Mean 55.2	Total 35.45

(d) *Subukia* (*Altitude* 7,000 *ft.*)

1952	*Mean temp. °F.*	*Rainfall (in.)*
January	62.0	0.75
February	63.7	0.61
March	65.1	0.10
April	63.1	7.76
May	61.9	9.64
June	60.6	3.66
July	60.5	2.31
August	60.2	5.02
September	60.7	3.64
October	61.1	5.47
November	60.5	3.72
December	61.3	0.42
	Mean 61.7	Total 43.10

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (SISAL), 1952

INVESTIGATIONAL WORK IN PROGRESS—HIGH LEVEL SISAL RESEARCH STATION, THIKA

Meteorological

Rainfall—	*inches*
January	0.22 in 1 day.
February	0.22 in 3 days.
March	1.45 in 3 days.
April	7.37 in 13 days.
May	7.93 in 13 days.
June	0.22 in 3 days.
July	0.28 in 6 days.
August	1.22 in 8 days.
September	2.06 in 4 days.
October	1.69 in 6 days.
November	4.50 in 16 days.
December	0.80 in 3 days.
Total	27.96 in 79 days.

The average rainfall for the 12 years of recording at this station covering 1941–1952 is 33.60 in.

Both the long and short rains started unusually late. The amount of rain which fell in the long rains was about average but the short rains were well below average.

A.—Nursery Trials

4/3.—Nursery Manurial and Mulching Trial

Object.—To compare the effects of fertilizers and sisal waste dug in and as a mulch on the growth rate of bulbils in nurseries.

Date of Commencement.—First cycle: 28th November, 1950.

Date of Lifting Plants.—First cycle: 20th March, 1952.

Date of Commencement.—Second cycle: 15th April, 1952.

Spacing.—2 ft. by 9 in. (29,040 plants per acre).

Treatments.—

N. 300 lb. sulphate of ammonia per acre.
K. 120 lb. muriate of potash per acre.
P. 180 lb. double super phosphate per acre.
C. 30 tons well rotted sisal waste dug in per acre.
M. 30 tons well rotted sisal waste mulched per acre.

Design.—2^5 factorial Confounded.

In the first cycle there was no response to double super phosphate or muriate of potash, but very significant responses to sulphate of ammonia and to sisal waste, the latter especially when dug in. The average increase in weight per plant was 0.61 lb. when applying sulphate of ammonia or when using sisal waste as a mulch, i.e. from 3.75 to 4.36 lb. per plant, whereas sisal waste dug in increased the weight from 3.33 lb. to 4.79 lb., or on average by 1.46 lb. per plant.

The only interaction which warrants comment is the sisal waste dug in with sulphate of ammonia added. This is also highly significant, and has on average increased the plant weight by 1.84 lb. per plant.

B.—Planting Material Trials

B/1.—Planting Method Trial

Object.—To compare yields when using graded old suckers from overgrown fields, graded young suckers from two-year-old fields and graded nursery plants produced from bulbils.

Date of Commencement.—24th April, 1949.

Spacing.—12 ft. by 2 ft. 6 in. (1,452 plants per acre).

Planting Material.—Old suckers, 19 in. high, weighing 6 lb.; young suckers, 15 in. high, weighing 1½ lb.; nursery plants, 18 in. high, weighing 4–5 lb.

Depth of Planting.—Deep: 7 in. deep for young suckers; 9 in. deep for old suckers and nursery plants. Shallow: Approximately 3 in. deep for all three planting materials.

Design.— 6 by 6 Latin square.

The tables for leaf count and leaf length after the recording for November, 1952, are as follows:—

	Leaf Count			Leaf Length		
	Shallow	Deep	Mean	Shallow	Deep	Mean
Nursery Plants	145·85	132·20	139·02	114·82	113·92	114·37
Young Suckers	142·17	133·77	137·97	106·25	108·40	107·33
Old Suckers	145·02	134·87	139·95	111·92	115·62	113·77
	144·34	133·61		111·00	112·65	

In leaf count the difference between the shallow and deep planted is highly significant in all cases, while there is no significant difference between the leaf count of the three planting materials.

There is no significant difference in leaf length between nursery plants and old suckers but they are both producing leaves longer than the young suckers at this stage. The differences in leaf length, which earlier were apparent between deep and shallow planting, no longer exist.

The plots were all cut when they reached a stage at which 95–105 leaves had been produced per plant since planting and a summary of the first cut indicates that although nursery plants and old suckers do not vary in yield yet they are both

yielding more than the young suckers, due to the young suckers having produced 8–10 leaves fewer of commercial length (2 ft.) than old suckers and nursery plants. For the first cut, deep planting appeared to yield slightly more fibre than shallow planting, which is probably due to the longer leaves in the initial stages.

An analysis was made of the coefficient of variance of length of last leaf produced before the first cut within each plot and it was found that unevenness within the three different planting materials did not vary significantly, which indicates that properly-graded suckers will grow as evenly as nursery plants. The collection and grading of suckers does, however, entail much more work than with nursery plants.

B/2 Planting Material Trial

Object.—To investigate the possibility of obtaining greater efficiency by using larger nursery plants and to investigate the effect of an earlier first cut than is normal practice in Kenya.

Date of Commencement.—3rd November, 1950.

Spacing.—13 ft. x 3 ft. by 2 ft. 9in. (1,980 plans per acre).

Planting Material.—Nursery plants, 9 in. high, weight about 1 lb.; nursery plants, 15 in. high, weight 3–3¾ lb.; nursery plants, 21 in. high, weight 6½–7 lb.

Age of First Cut.—Early, 80–90 leaves produced since planting; normal 100–110 leaves produced since planting; late, 120–130 leaves produced since planting.

Intensity of Cut.—Heavy, leaving 25 leaves after first cut and 20 leaves after subsequent cuts; medium, leaving 35 leaves after first cut and 30 leaves after each subsequent cut; light, leaving 45 leaves after first cut and 40 leaves after each subsequent cut.

Design.—3^3 factorial Confounded. Two replications.

Analysis of the figures for leaf count for November, 1952, indicates that the difference in number of leaves produced at this stage is not significant between the 9 in. and 15 in. plants, but the 21 in. plants have produced a significantly higher number of leaves than the smaller plants.

The differences in length of the last unfurled leaf for November, 1952, are highly significant, indicating that big planting material will reach a given leaf length before small material. The age of this trial (two years) must, however, be kept in mind and too much significance should not be attached to the interim results which are now available.

The treatments which were due for a first cut when the plants reached the 80–90 leaf stage after planting, were cut on 17th November, 1952. This is an extremely early cut and can only be considered a cultivation cut, i.e. a cut to facilitate cleaning and desuckering. The effect on the subsequent development of the plants should be interesting.

B/3 Bulbils, Nursery Plants and Suckers Trial

Object.—To compare bulbils planted *in situ* in the field with nursery plants and suckers, and further to compare flat and ridged planting on red soils.

Date of Commencement.—7th November, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

(1) Bulbils: Average weight 3 oz. planted *in situ* in fields.

(2) Nursery plants: 15 in. high, weight 3–3¼ lb.

(3) Suckers from old areas: 25 in. high weighing 10–12 lb.

(4) Ridged versus flat.

Design.—6 by 6 Latin square.

Each plot in this trial consists of only six plants so it is more in the nature of a look-see trial, and the results obtained will be a guide for further investigation.

The main interest of this trial centres round the evenness of the three planting materials during their growth. About 10 per cent replacements had to be made in the Bulbil plots and none in the plots of the other planting materials. Also the development of the direct planted bulbils is a good deal less than that of the nursery plants.

After two years in the field a coefficient of variance over all the plants was taken on the last unfurled leaf as an indication of the height of the plants and it was found that the variations within bulbils were considerably greater than in nursery plants or suckers, there being only little difference in the evenness between the two latter planting materials.

This strengthens the contention that although the nursery plants receive a check when they are transplanted, this method, which gives a more even stand of plants, is preferable to planting bulbils straight into the field.

B/4 Grading of Planting Material Trial

Object.—To investigate which factor or factors influence most the evenness of growth in height of plants in sisal fields.

Date of Commencement.—17th April, 1952.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

(*a*) Grading by height only.

(*b*) Grading by girth only.

(*c*) Grading by weight only.

The above treatments were factorially combined.

The control plots were planted with plants taken at random from the nursery without any attempt at selection. There is so far nothing to report on this trial.

C.—Land Preparation Trials

C/1 Uniformity Trial Ridging versus Flat (Trans Nzoia)

Object.—To compare the relative merits of planting sisal on the flat and on ridges on the red soils in the Trans Nzoia area. This trial is also being used as a uniformity trial.

Locality.—Adjacent to the main trial at Ziwa, Ltd., Hoey's Bridge. (D/4.)

Date of Commencement.—11th April, 1948.

This trial grew very evenly, but has shown no significant difference between the ridged and flat planting. This trial is now being abandoned as it has produced all the information that can be expected from it.

C/2 Flat versus Ridged versus Sub-soil Treatment Trial

Object.—To ascertain whether sub-soiling or ridging will improve the rate of growth on the sandy soils of Kampi-ya-Moto.

Locality.—Adjacent to the main trial on Alphega Estate, Kampi-ya-Moto. (D/5.)

Date of Commencement.—24th October, 1948.

No significant differences can be seen in leaf count, leaf length or yield figures, but it must be noted that the soil variations within the trial area are so great that they could have masked any treatment effects which might have shown up on more homogeneous land.

This trial will now be discontinued and no further results on it will be published.

D.—Plant Management Trials

D/1 Spacing Trial

Object.—To investigate the effect of various spacings on sisal yields.

Date of Commencement.—February, 1941.

Treatments.—Eight different spacings and populations.

Method of Cutting.—First cut at 3½ years followed by cuts at yearly intervals.

Design.—Six randomized blocks.

This trial was cut in September, 1952, leaving only one plot in the 22 ft. by 2 ft. by 2¼ ft. spacing to complete, as all other plots have poled out 100 per cent.

The following table gives a summary of yield figures, etc., up to September, 1952:—

Spacing	15′x4′	11′x4′	18′x3½′x4′	12′x3′	15′x2′	22′x2′x2½′	11′x2¼′	10′x2′
Population	726	960	1,013	1,210	1,452	1,613	1,760	2,178
Number of leaves produced per plant	274.5	277.3	275.5	276.1	272.8	272.3	269.6	270.2
Number of leaves cut per plant	228.9	228.6	228.4	230.1	231.0	229.1	226.4	227.1
Weight in lb. of leaves cut per plant	398.2	367.5	376.0	376.3	379.9	364.7	360.0	354.4
Tons of unbrushed fibre per acre	4.24	5.60	5.73	6.86	8.74	9.15	9.73	11.96
Poling percentage	100.0	100.0	100.0	100.0	100.0	97.92	100.0	100.0
Age at time of last cut or at 100 per cent poling	7½ yrs.	8 yrs.	9½ yrs.	10½yrs.	11½yrs.	11½yrs.	10½yrs.	11½yrs.
Yield per acre per year of cycle (tons)	0.57	0.70	0.60	0.76	0.76	0.80	0.93	1.04

A complete analysis of this trial will be made when the final cut has been taken, but the general trend of higher yields with higher populations is obvious from the above figures.

D/2 Cutting Trial

Object.—To investigate the effect of cutting on the sisal plant.

Date of Commencement.—March, 1941.

Spacing.—12 ft. by 3 ft. (1,210 plants per acre).

Treatments.—Commencement of cutting: 3½ years, 4 years, 4½ years; interval between cuts: 6 months, 12 months, 18 months; intensity of cut: Light, leaving 36 leaves after each cut; heavy, leaving 12 leaves after each cut.

Design.—3 by 3 by 2 factorial with four replications.

This trial was cut in February and August according to programme, leaving only a few unpoled plots in the heavily and frequently cut treatments.

A summary of results to date is given below:—

	1st Cut at			Intervals between cuts			Intensity of cut	
	3½ years	4 years	4½ years	6 months	12 months	18 months	Heavy	Light
Number of leaves lost over 24 inches	5.6	12.2	23.8	13.7	13.6	14.3	14.4	13.3
Number of leaves produced per plant	290.2	272.1	267.1	287.6	275.9	266.0	286.6	266.3
Number of leaves cut per plant	242.0	212.2	195.7	225.9	216.6	207.3	224.6	208.6
Weight in lb. of leaves cut per plant	365.7	365.9	369.4	370.5	362.3	368.3	362.8	371.2
Tons of unbrushed fibre per acre	6.70	6.14	5.96	6.45	6.14	6.22	6.20	6.32
Poling percentage	88.19	95.63	99.38	83.40	99.79	100.0	88.79	100.0
Age at time of last cut or 100 per cent poling	11½yrs.	11½yrs.	11½yrs.	11½yrs.	11½yrs.	11 yrs.	11½yrs.	10 yrs.
Yield per acre per year of cycle (tons)	0.58	0.53	0.52	0.56	0.53	0.57	0.54	0.63

A full analysis of the data from this trial will be published when it is concluded in 1953.

The object of the following five external trials is to ascertain variations in growth rates in the various districts of Kenya using different spacing and cutting treatments.

Treatments for all the five trials are as follows:—

Spacing.—11 ft. between single rows; 14 ft. between single rows; 18 ft. by 3 ft. double row planting.

Populations.—1,200 plants per acre; 1,600 plants per acre; 2,000 plants per acre.

Development at First Cut.—100 leaves grown since planting; 125 leaves grown since planting; 150 leaves grown since planting.

Severity of Cutting.—Light, leaving 30 leaves after each cut; medium, leaving 20 leaves after each cut; heavy, leaving 10 leaves after each cut.

Design.—3^4 factorial arranged as a 9 by 9 quasi Latin square.

D/3 Ruiru Trial (Black Cotton Soil) Ridged

Locality.—Juja Farm, Ruiru.

Date of Commencement.—16th March, 1948.

Summary of results up to 1st October, 1952:—

	Average No. of Leaves Grown per Plant				Leaf Length in Inches for the Last Unfurled Leaf			
	Spacing between rows				Spacing between rows			
Spacing	14′	11′	18′x3′	Mean	14′	11′	18′x3′	Mean
Population:								
1200	137.86	142.50	145.91	142.09	43.74	43.11	44.77	43.87
1600	120.41	124.68	124.60	123.23	41.28	41.28	42.29	41.62
2000	111.70	118.90	118.60	116.40	41.80	41.65	41.34	41.60
Mean	123.32	128.69	129.70	127.24	42.27	42.02	42.80	42.36

Least significant differences between two means:—

	Leaf Count	*Leaf Length*
P = 0.05	7.20	2.11
P = 0.01	9.69	2.85

Least significant differences between two 2-factor interactions (i.e. figures shown in the body of the tables):—

	Leaf Count	*Leaf Length*
P = 0.05	12.47	3.66
P = 0.01	16.79	4.93

As the difference between two means in leaf count has got to be at least 7.20 to be significant it is clear that the distance between rows has influenced the rate of leaf production too little to make the differences of the figures significant. It is equally clear that although the difference between 2,000 and 1,600 plants does not quite reach significance they have both produced significantly fewer leaves per plant than the population of 1,200 plants per acre. It must, however, be remembered that these figures are for leaf count *per plant* and to get the relative leaf count per acre the figures would have to be multiplied by the appropriate number for plants per acre. This latter figure, which influences fibre yield, is, of course, of great interest in the commercial growing of sisal.

Twenty-seven plots were cut in September, 1952, when they had produced 125 leaves since planting.

The unevenness of the soil in the trial area, mentioned in last year's report, has been a subject of extensive study by the Soil Chemist of the Agricultural Department. The origin of the roughly circular "islands" of 20–50 yd. diameter with intervals of 50–150 yards between them which are so characteristic of the black cotton soils, is still undetermined. The growth of sisal is better on the "islands" than on the surrounding land and this is apparently due to better drainage and physical properties of the soil on the "islands".

At the moment the most promising way of obtaining an even stand of sisal on black cotton soil would appear to be by means of ripping and ploughing in conjunction with ridging. The physical properties can also be improved by the incorporation of large quantities of organic matter in the soil.

D/4 Trans Nzoia Trial

Locality.—Ziwa Estate, Ltd., Hoey's Bridge.

Date of Commencement.—10th April, 1948.

Summary of results up to October, 1952:—

	Average No. of Leaves Grown per Plant				Leaf Length in Inches for the Last Unfurled Leaf			
	Spacing between rows				Spacing between rows			
Spacing / Population:	14′	11′	18′x3′	Mean	14′	11′	18′x3′	Mean
1200	169.94	176.50	167.91	171.45	43.64	43.55	42.88	43.36
1600	157.19	162.70	158.44	159.44	43.18	42.63	42.91	42 91
2000	144.79	152.59	150.44	149.27	42.27	41.83	42.32	42.14
Mean ..	157.31	163.93	158.93	160.05	42.03	42.67	42.70	42.80

Least significant differences between two means:—

	Leaf Count	*Leaf Length*
P = 0.05	2.41	0.99
P = 0.01	3.24	1.33

Least significant differences between two 2-factor interactions:—

	Leaf Count	*Leaf Length*
P = 0.05	4.17	1.71
P = 0.01	5.62	2.31

The 11 ft. spacing has produced a significantly greater number of leaves than the 14 ft. or 18 ft. by 3 ft. spacing, and the differences in leaf count between the three populations are highly significant. This may be due to less interplant competition as the distance between plants in the row is greater with a row spacing of 11 ft.

The differences in marginal means in the leaf length table are not significant.

The increase in leaf length of the plants receiving the early first cut at 100 leaf stage has been less than that of the two later first cuts. The object of an early first is to give the plants a check, but it is still too early to draw conclusions from results to date.

D/5 Kampi-ya-Moto Trial

Locality.—Alphega Estate, Kamp-ya-Moto.

Date of Commencement.—23rd October, 1948.

Summary of results for last recording at October, 1952:—

	Average No. of Leaves Grown per Plant				Leaf Length in Inches for the Last Unfurled Leaf			
	Spacing between rows				Spacing between rows			
Spacing / Population:	14′	11′	18′x3′	Mean	14′	11′	18′x3′	Mean
1200	136.6	144.9	122.4	134.6	42.91	45.20	37.36	41.81
1600	126.9	130.9	122.8	126.9	42.20	40.24	39.80	40.75
2000	114.4	123.0	111.1	116.2	39.68	40.31	35.98	38.66
Mean ..	126.0	132.9	118.8	125.9	41.61	41.93	37.72	40.40

Least significant differences between two means:—

	Leaf Count	*Leaf Length*
P = 0.05	4.19	2.30
P = 0.01	5.64	3.10

Least significant differences between two 2-factor interactions:—

	Leaf Count	*Leaf Length*
P = 0.05	7.27	3.96
P = 0.01	9.79	5.34

The differences in the marginal means of the table for leaf count are highly significant. The interaction between the population and spacing, the figures appearing in the body of the table, is clearly shown. The difference between any two figures has got to be 7.3 or 9.8 to be significant on the probability levels of P = 0.05 and P = 0.01 respectively.

In the leaf length table the difference between two marginal means has got to be 2.3 and 3.1 to be significant on the probability levels of P = 0.05 and P = 0.01 respectively. This indicates that the double-row spacing has produced a leaf significantly shorter than the two single-row spacings, but there is no significant difference between the single-row spacings. There is no significant difference between the leaf lengths of plants at the 1,200 and 1,600 populations, but the 1,200 population is significantly better than the 2,000 plants per acre.

One-third of the trial was cut in February, when the plants had produced 100 leaves since planting. The second third was cut in October when the plants had produced 125 leaves. There are indications that the early first cut has retarded the normal increase in the leaf length of leaves produced subsequently.

D/6 Thika Trial (Red Soil)

Locality.—Anglo-French Sisal Estate, Thika.

Date of Commencement.—17th November, 1948.

Summary of results as for 1st December, 1952:—

	Average No. of Leaves Grown per Plant				Leaf Length in Inches for the Last Unfurled Leaf			
	Spacing between rows				Spacing between rows			
Spacing	14′	11′	18′x3′	Mean	14′	11′	18′x3′	Mean
Population:								
1200	156.68	165.21	150.93	157.61	48.38	49.25	46.34	47.99
1600	139.41	151.34	139.44	143.40	47.72	48.23	45.28	47.09
2000	125.70	140.86	134.21	133.58	45.51	47.87	47.60	47.01
Mean	140.60	152.47	141.53	144.86	47.20	48.43	46.42	47.36

Least significant differences between two means:—

	Leaf Count	*Leaf Length*
P = 0.05	2.84	1.19
P = 0.01	3.82	1.60

Least significant differences between two 2-factor interactions:—

	Leaf Count	*Leaf Length*
P = 0.05	4.92	2.06
P = 0.01	6.62	2.77

From the mean figures in the leaf count it is apparent that there is no significant difference between the number of leaves produced in the 14 ft. and 18 ft. by 3 ft. spacing, but the 11 ft. spacing has produced a significantly greater number of leaves than the other two. The differences between leaf counts of the various populations are highly significant.

Two of the first cuts were taken on this trial on 3rd September, 1951, and 8th May, 1952, when the respective plots reached an average of 100 and 125 leaves produced since planting. The third first cut will be taken when the appropriate plants reach the 150-leaf stage.

Shortening of the leaves due to the early first cut (when the plants had produced 100 leaves) is clearly apparent in the trial.

D/7 Kibwezi Trial

Locality.—Dwa Plantations, Ltd., Kibwezi.

Date of Commencement.—21st October, 1949.

Summary of results up to 1st November, 1952.

	Average No. of Leaves Grown per Plant				Leaf Length in Inches for the Last Unfurled Leaf			
	Spacing between rows				Spacing between rows			
Spacing	14′	11′	18′x3′	Mean	14′	11′	18′x3′	Mean
Population:								
1200	114.1	118.4	113.9	115.5	53.70	52.91	52.01	52.87
1600	105.8	112.9	104.9	107.9	54.49	54.41	51.30	53.42
2000	94.3	104.9	98.1	99.1	51.81	54.13	52.20	52.72
Mean	104.8	112.1	105.6	107.5	53.35	53.82	51.85	53.00

Least significant difference between two means:—

	Leaf Count	*Leaf Length*
P = 0.05	2.75	1.06
P = 0.01	3.71	1.43

Least significant difference between two 2-factor interactions:—

	Leaf Count	*Leaf Length*
P = 0.05	4.77	1.83
P = 0.01	6.43	2.76

This trial was given its early first cut on 8th July, 1952, when the appropriate 27 plots had produced 100 leaves since planting. So far none of the cutting treatments has had any effect on leaf count or leaf length.

The 11 ft. spacing is also here significantly better than the 14 ft. or 18 ft. by 3 ft. spacings as far as leaf count is concerned, and the differences in leaf count in the three populations are highly significant.

Neither population nor spacing seem, however, to have affected the leaf length to an appreciable extent although the 18 ft. by 3 ft. spacing is just significantly shorter than the 11 ft. spacing.

D/8 Double versus Single Row Trial

Object.—To compare various plant-populations and row spacings, and to establish whether a certain plant population will perform equally well whether planted in single row or double rows, when the distance between rows is the same.

Date of commencement.—15th April, 1952.

Populations.—1,600 plants per acre; 2,000 plants per acre; 2,400 plants per acre.

Distance Between Rows.—11 ft.; 13 ft.

Row Spacing.—Double rows, 3 ft. between rows; single rows.

These treatments cover the following range:—

Single Row	*Double Row*	*Populations Per Acre*
11′ × 2′ 6″ ..	11′ × 3′ × 4′ ..	1,600
11′ × 2′ ..	11′ × 3′ × 3′ ..	2,000
11′ × 1′ 8″ ..	11′ × 3′ × 2′ 6″ ..	2,400
13′ × 2′ ..	13′ × 3′ × 3′ 6″ ..	1,600
13′ × 1′ 9″ ..	13′ × 3′ × 2′ 9″ ..	2,000
13′ × 1′ 5″ ..	13′ × 3′ × 2′ 3″ ..	2,400

Design.—3 by 2 by 2 partially Confounded.

This trial is obviously too young to show responses but from the October, 1952, recording there would appear to be a tendency for the rate of leaf production to be related, even at this early stage, to plant population, spacing and row spacing.

E.—Cultivation Trials

E/1 Cultivation Trial

Object.—To investigate the effect on the soil and sisal plants of continuous clean weeding by mechanical means as against restricted weeding with and without a controlled grass cover in the area between sisal lines.

Date of Commencement.—1st November, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

(1) Grass strip slashed frequently to keep grass low.

(2) Grass strip cut periodically and the cut grass used as mulch round sisal plants.

(3) Clean weeded by frequent discing for the first three years, then as (2).

(4) Clean weeded by frequent discing for the first three years, then discing twice a year.

(5) Discing twice a year for the whole cycle.

(6) Clean weeding by frequent discing for the whole cycle.

This trial incorporates the above treatments with sisal planted on the flat and on ridges. The grass cover is obtained by sowing Rhodes grass (*Chloris gayana*) in 6 ft. wide strips between the double rows, at the rate of 19 lb. of seed per acre of the area sown.

Design.—Four randomized blocks each of 12 plots.

This trial is an exceptionally good-looking area of sisal and is a good example of how sisal will grow under suitable conditions.

During the first month after planting 4.21 in. of rain fell on 13 days (i.e. November, 1950) but December, January and February were very dry with a total of 0.30 in. in four days. It was then followed by an exceptionally wet year (total for 1951 was 60.68 in.), but the rainfall for 1952 was normal.

Although the first four months did not give the plants much of a chance. the virgin soil, combined with the rain and good management have produced a very uniform stand of sisal which after two years had produced an average of 87 leaves. This means it will be ready for a cut at $2\frac{1}{2}$ or $2\frac{3}{4}$ years—an outstanding performance for the Central Province.

There is as yet no significant difference between the growth-rates in the different treatments but so far the sisal has had only a limited amount of competition from the grass strips. Differences are expected during the later years of this trial when competition for moisture will be greater and differences may also be anticipated in the future cycles when the crumb structure of soil in the clean-weeded plots may have deteriorated.

F.—Fertilizer Trials

F/1 Fertilizer Trial

Object.—To investigate the effect on the growth rate of sisal plants of applying artificial fertilizers and/or sisal waste.

Date of Commencement.—16th March, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

(1) Sulphate of ammonia (N) applied at the rate of 388 lb. per acre in each of the first four years of the cycle.

(2) Double super phosphate (P), applied in shallow trenches under the plants a week before planting at the rate of 260 lb. per acre.

(3) Muriate of potash (K), applied at the rate of 395 lb. per acre for the first year and 300 lb. per acre during each of next three years.

(4) Agricultural lime (Ca) (96 per cent $CaCO_3$), broadcast over the whole treated area at the rate of 2.0 tons per acre, a month before planting.

(5) Sisal waste (W) as fresh sisal waste taken straight from a Corona decorticator, decorticating dry. The waste was applied at the rate of 107 tons wet waste per acre and dug in one month before planting in strips covering an area 4 ft. each side of the double rows.

Design.—2^5 factorial.

The responses to the fertilizer treatments are very striking in this trial. The average increases in leaf number of the plots receiving N, Ca, P and waste over the plots not receiving these are 3.50, 3.70, 5.76 and 13.48 respectively which are all significantly higher than the untreated. The potash application gave no significant response.

The results for leaf count are followed very closely when analysing the figures of leaf length. The plots in this trial are having a first cut when the number of leaves produced since planting reached 110–120. The first plots reached this stage in September, 1952, and it is of interest to note that of the 16 plots receiving K, 6 were cut; Ca, 6 were cut; N, 7 were cut; P, 8 were cut; W, 11 were cut.

This gives a clear indication of the stimulus to the initial growth given by an application of sisal waste.

It is of interest to note that the plots which were cut yielded in the vicinity of half ton of unbrushed fibre per acre. It is outstanding to have a return of this order, in so short a time after planting. The land used for this trial had carried one cycle of sisal yielding 4 tons per acre, before this trial was planted.

F/2 Sisal Waste and Minerals Trial

Object.—To compare the effect of different methods of applying fresh sisal waste, sisal waste reinforced with artificial fertilizers and artificial fertilizers alone.

Date of Commencement.—17th March, 1950.

Treatments.—

	Fresh Sisal Waste	Sulphate of Ammonia	Double Super Phosphate	Muriate of Potash	Agric. Lime ($CaCO_3$ 96%)
	Tons	*lb.*	*lb.*	*lb.*	*Tons*
A Control	Nil	Nil	Nil	Nil	Nil
B Waste half dug in and half as mulch	107	Nil	Nil	Nil	Nil
C Waste all dug in	107	Nil	Nil	Nil	Nil
D Waste all as mulch	107	Nil	Nil	Nil	Nil
E Waste half dug in and half as mulch with minerals added	107	390	65	325	0·42
F Waste all dug in with minerals added	107	390	65	325	0·42
G Waste all as mulch with minerals added	107	390	65	325	0·42
H Minerals only	Nil	1,560	260	1,300	2·0

(1) The waste, lime and super phosphate were applied before planting as in the fertilizer trial. Sulphate of ammonia applied with waste at the rate of 129 lb. per acre for first year and 87 lb. per acre during each of the next three years. Applied without waste at the rate of 522 lb. for the first year and 346 lb. per acre during each of the next three years.

(2) Muriate of potash applied with waste at the rate of 130 lb. per acre the first year and 65 lb. during each of the next three years. Applied without waste at the rate of 520 lb. per acre for the first year and 260 lb. during each of the next three years.

Design.—Four randomized blocks of eight plots.

The analysis of the figures gives the following results at October, 1952, which is the last recording:—

	A	B	C	D	E	F	G	H	Mean
Leaf Count	101·03	113·28	111·95	113·80	116·65	118·55	115·98	113·53	113·09
Leaf Length in inches	37·19	40·16	39·77	39·70	43·70	44·03	42·57	41·74	41·11

To be significant on the P = 0.05, P = 0.01, and P = 0.001 levels the difference between two means on leaf count has got to be 5.54, 7.52 and 10.18 respectively which means that all treatments are significantly better than the Control, although there is little difference between the treatment responses.

For leaf length the figures are 3.07, 4.17 and 5.62 respectively which seems to indicate that all treatments with artificial fertilizers have boosted the leaf length whether in the presence or absence of sisal waste. The application of sisal waste alone has increased the leaf length although the difference has not quite reached significance. Twenty-four of the total of 32 plots in this trial were cut at the end of September, 1952, when they had produced 110–120 leaves since planting.

An analysis of the yield figures cannot be made until all the plots have received a first cut.

F/3 Rotational Fertilizer Trial (Anglo-French)

Object.—To investigate the effect on sisal of resting the land under grass for a period of years between the cycles with and without a grass cover during the cycle. These treatments are combined with fertilizer treatments on bare land and grass strips between the sisal rows.

Locality.—Anglo-French Sisal Estate, Thika.

Date of Commencement.—24th November, 1952.

Treatments.—

First Cycle	*Second Cycle*
(1) Clean weed by frequent discsing throughout.	As first cycle.
(2) Plant grass strips, cut grass and mulch along sisal rows.	As first cycle (sisal replanted where grass strips were).
(3) Plant grass strips, cut grass and mulch along sisal rows.	Leave grass strips to cover land for three years; then replant sisal and treat as first cycle.
(4) Clean weed by frequent discing throughout.	Three years grass ley then as first cycle.

Superimposed on the above treatments are the following fertilizer treatments:—

Control, N, P, Ca, NP, NCa, PCa and NPCa.

Sulphate of Ammonia (*N*): 200 lb. per acre for the first four years of the cycle.

Double Super Phosphate (*P*): 150 lb. per acre at planting.

Agricultural Lime (*Ca*): Two tons per acre just before planting.

Design.—Six randomized blocks of four plots each. Each plot split for N. P and Ca (24 plots or 96 split plots).

Planting.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

The trial area, which was fairly heavily infested with "couch" grass (*Digitaria Scalarum*) was sprayed with T.C.A. at the rate of 30 lb. per acre. It is hoped that useful information on the control of "couch" grass by chemical means will also result from this trial.

F/4 Fertilizer, Waste and Grass Trial

Object.—To investigate the effect of N, P, Ca and sisal waste on old sisal land with and without grass strips introduced between the sisal lines.

Locality.—Anglo-French Sisal Estate, Thika. The area was first planted with sisal in 1925 and two cycles have been taken off, yielding a total of 6.42 tons per acre.

Date of Commencement.—3rd December, 1952.

Treatments.—The following applications were applied singly and in all possible combinations:—

Sisal Waste.—Collected from a rotary pulp extractor and applied at the rate of 20 tons per acre in 6 ft. strips covering the planting lines.

Sulphate of Ammonia (*N*).—200 lb. per acre applied close to the plants during the first rains after planting.

Double Super Phosphate (*P*).—150 lb. per acre applied as 108 lb. per acre at planting by dropping $\frac{7}{8}$ oz. under each plant. The balance to be applied later in the centre of the wide space between the double rows.

Agricultural Lime (*Ca*).—At the rate of 2 tons per acre applied broadcast on 1st December, 1952.

Grass.—Molasses grass (*Melinis minutiflora*) to be planted as strips between the sisal rows.

Planting.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Design.—2^5 factorial Confounded.

The area which was "couch" infecsted was also sprayed with a solution of T.C.A. at the rate of 30 lb. per acre.

G.—Deficiency Disease Trials

The Potash Trial (G/1) for banding disease and the Leaf-Tip Die-Back Trial (G/2) have shown little response to treatments, mainly due to the uneven distribution of diseased plants in the area of the trial. This unevenness prevents an accurate analysis of results. It would, however, appear that the application of potash has reduced the severity of banding disease.

It has been decided to abandon the Leaf-Tip Die-Back Trial.

H.—Production of Improved Planting Material Trials

H/1 Hybrid Variety Trial

Object.—To observe and compare the performance of common sisal with eight promising hybrids received from Mlingano Experimental Station, Ngomeni, Tanganyika.

Date of Commencement.—7th April, 1952.

Treatments.—Hybrids Nos. 1155, 1269, 1300, 1317, 1475, 1660, 6964, 7131 (all obtained from Mlingano Experimental Station, Ngomeni, Tanganyika Territory), common sisal (*Agave sisalana*).

Design.—Three by three balanced lattice. Nine treatments and four replications.

Planting.—13 ft. by 3 ft. by 2 ft. 9 in.

There is so far little to report on this trial although most of the hybrids have produced leaves at a higher rate than sisal during the first six months, but there is little difference in the leaf lengths in these early leaves.

H/2 Plant Selection Trial

Object.—To compare common sisal (*Agave sisalana*) with progeny of what has in some cases wrongly been termed non-flowering sisal.

Date of Commencement.—20th April, 1952.

Treatments.—From a so-called non-flowering plant No. 2 (Carver ex Juja) three suckers were collected. When they poled, bulbils were collected and the subsequent nursery plants are here marked A, B and C. Suckers from a non-flowering plant No. 1 (Everard ex Donyo Sabuk) were planted and marked D. The common sisal is marked E.

Design.—Six randomized blocks of five treatments.

Planting.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Although it is much too early to report on this trial it is noticeable that the rate of leaf production has already been faster on the selected plants than on common sisal, but common sisal has from the start produced an appreciably longer leaf.

J.—Herbicide Trials

J/2 started on 1st May, 1951, using different rates of Iso-propyl-phenyl-carbamate (I.P.P.C.) and sodium trichloroacetate (T.C.A.). The herbicides were applied to a heavily "couch" infested area after one ploughing and harrowing. The sisal was planted about a fortnight later.

The following observations were made 12 months after spraying:—

Treatments	A	B	C
	%		%
Control per acre	93	13·8	—
100 lb. I.P.P.C. per acre..	88	13·8	0
300 lb. I.P.P.C. per acre..	95	14·6	6
10 lb. T.C.A. per acre ..	55	23·4	70
20 lb. T.C.A. per acre ..	25	26·1	89
40 lb. T.C.A. per acre ..	18	27·6	100

A=Estimated per cent ground cover of "couch" grass.
B=Actual number of leaves produced per plant.
C=Per cent increase (over the control) in number of leaves.

(1) Ten pounds T.C.A./acre has given a complete control of "couch" for three months and even after 12 months, only half the ground was covered by "couch". The interesting point in connexion with this treatment is that in spite of the regrowth of "couch", these plots have produced 70 per cent more leaf than the control plots in 12 months.

(2) Twenty pounds T.C.A./acre has given a complete control of "couch" for a period of 6–8 months and after 12 months the infestation only covers one-quarter of the ground area. Leaf production is 89 per cent greater than the leaf production on the control.

(3) Forty pounds T.C.A./acre has given a complete control of "couch" for a period of 10 months and after 12 months the infestation of "couch" is only slight. The production of leaf in 12 months has doubled that of the control.

(4) The I.P.P.C. treatments have proved ineffective.

(5) The sisal plants growing in the T.C.A. plots were in all cases of a larger size and a deeper green in colour. Therefore in addition to the extra leaves produced per plant on all T.C.A. plots, the leaves were of increased length and consequently of increased weight.

J/4 Started 16th May, 1952

This trial is a comparison of two rates, 10 lb. and 30 lb. of T.C.A./acre with two rates of water, 20 and 80 gallons per acre. To date, after seven months, the 10 lb. T.C.A. plots have shown a 40 per cent ground cover of "couch" and the 30 lb. T.C.A. plots have shown a 15 per cent cover compared with the control plots which have shown a 60 per cent "couch" cover. The same trends are showing up in this trial as were observed in the 1951 trial. There would appear to be little to no difference between the 20-gallon and the 80-gallon rates of water on the 30 lb. T.C.A. plots, but on the 10 lb. T.C.A. plots there is a distinct trend towards greater effectiveness with the 80-gallon rate than with the 20-gallon rate. No leaf counts have been recorded as yet.

Summary

Nurseries.—Sisal waste has given consistently better results than organic fertilizers in bulbil nurseries. However, if sulphate of ammonia is added to sisal waste, the rate of growth is further accelerated (A/3). It would appear that sisal waste is best applied by digging it into the soil before planting the bulbils.

Planting Material.—Nursery plants produced from bulbils are recommended but suckers do well if careful grading is done. Bulbils planted out in the field are likely to produce an uneven stand of plants and losses are more likely to occur than with the larger nursery plants (B/3). The grading of planting material is a most important factor in obtaining an even stand of sisal.

Big plants grow faster and reach the stage of first cut sooner than small plants (B/1).

Spacing.—The Spacing Trial (D/1) has clearly shown that yields per acre per annum of the cycle increase as populations increase. This fact is borne out by experiments in other sisal growing countries. Six trials (D/3–D/8) have been planted in different parts of the country with the object of ascertaining the optimum spacings to be used. It must be emphasized that climate and soils will place a limit on the number of plants which a given area will carry. The results from trials show that populations up to 2,000 plants per acre do not reduce leaf length. Sisal grown at Kibwezi produces a longer leaf than sisal in the Thika District, which in turn is longer than the leaves grown at Kampi-ya-Moto and Hoey's Bridge. It would therefore appear that the length of leaf is largely dependent on soil fertility and climate.

Cutting.—Several trials (B/2 and D/3–D/8) are now in progress, in different districts, with the object of ascertaining the optimum stage of plant development at which a first cut should be taken and the severity of cutting that should be practised. These trials are still in their early stages and it is too soon to draw final conclusions, but light cutting, leaving about 30 leaves after cutting, is recommended. The object of an early cut is to check the growth of the plant and thus prevent it from poling prematurely. Cutting at the 100-leaf stage has retarded the normal increase in leaf length and it will be most interesting to note in the external trials whether this is only a transitory effect.

Manuring and Maintenance of Soil Fertility

The replanting of old sisal areas during recent years and the appearance of deficiency diseases have focussed attention on the need for manuring. Trials at the Station have shown spectacular responses to sisal waste, similarly good results have also been obtained with the application of fertilizers containing calcium, nitrogen, phosphate and potash (F/1 and F/2). It is gratifying to record that sisal waste is being used on an increasing scale with good results on estates. The use of sisal waste as manure is strongly recommended, especially as it is readily available on all estates.

The use of grass strips between sisal rows is being investigated as the strips would assist in controlling soil erosion and in supplying material for mulching.

Trials are now in progress to ascertain the effect of controlled grass strips on the growth of sisal.

Herbicides Control of "Couch" Grass (Digitaria Scalarum)

Promising results are being obtained with a pre-emergent spray of sodium trichloroacetate (T.C.A.) used on cultivated land before sisal is planted (J/2 and J/4). It is essential that spraying should be done on moist soil as dry conditions apparently cause decomposition of the chemical before it can be absorbed by the "couch" roots.

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Agricultural Officer (Sisal).

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Weather Conditions

It was a very difficult year due to the scarce and badly distributed rainfall. During planting times periods of drought lasting several weeks alternated with brief rainy periods. Much of the rain fell in ineffective showers of only a few points at a time. Along the Coastal strip where nearly all experimental work was carried out the situation was uniformly bad except at Shimba Hills which had a higher and better distributed rainfall. Most experiments were successful despite the conditions but the sugar experiments at Ramisi had to be postponed from the long rains until the short rains and the cotton experiment at Matuga had to be replanted. The monthly totals of rainfall at the main experimental centres are as follows:—

	Matuga	Kibarani	Gede	Shimba Hills
January	0·58	0·20	0·00	0·75
February	0·04	0·80	0·00	0·10
March	1·46	1·18	1·21	1·73
April	1·59	0·90	2·62	3·33
May	6·59	4·09	2·37	9·09
June	3·36	6·58	4·66	5·14
July	0·63	1·01	1·28	0·82
August	1·77	1·80	2·37	2·96
September	3·08	1·63	2·35	2·12
October	1·86	2·61	0·75	3·17
November	5·16	3·44	2·34	8·21
December	0·24	2·52	0·65	1·85
TOTAL	26·36	26·76	20·60	39·27
Total Number of Days	88	97	64	104

Cassava

EXPERIMENT NO. 4/1/1.—(*a*) DISEASE RESISTANCE TRIAL, MATUGA

A trial for testing the disease resistance of a number of clones of cassava was started in May, 1952. The number included was 43, the majority being hybrids ex Amani but a number of varieties of ordinary cassava were also tried. Twenty plants of each clone under trial were planted out in an unreplicated plot between hedges of diseased material. The material for these hedges consists of cassava collected from widely scattered parts of the coastal strip and covers a wide range of local varieties. It is susceptible to the virus diseases mosaic and brown streak and in the hedges shows a heavy infection of mosaic. Brown streak disease is also present in the hedges but the severity of the infection cannot yet be accurately assessed.

Individual records for the performance of each plant of the trial clones have been taken at regular intervals. The individual record has been chosen rather than the percentage of infected plants in order that the course of the infection may be followed. For example, there is the possibility that a plant may show mosaic sypmtoms in its early stages and later grow away from the attack. The records so far

give a good indication of resistance to mosaic but the resistance to brown streak will not be accurately assessed until the crop has been lifted and the tubers examined for symptoms. Results to date are promising.

Table I gives a summary of the position to date. This table does not set out individual plant records since the progress of the disease in the plant appears to be reasonably straightforward. In the later stages a few plants earlier recorded as being infected have shown no symptoms. This, however, has mostly been found to be a result of partial defoliation during a drought when lightly infected plants may shed a large number of leaves including those which showed the virus symptoms. Later these same plants will again exhibit symptoms. In a few cases there appears to be a genuine recovery.

TABLE I.—MOSAIC INFECTION OF CASSAVA CLONES GROWN AT MATUGA

VARIETY	Genetic Origin	NUMBER OF INFECTED PLANTS OUT OF 20					
		At 2 Months	At 3 Months	At 4 Months	At 6 Months	At 7 Months	At 10 Months
4318/18	Cassava x M. Glazovii	0 (19)	0 (19)	0 (19)	0 (19)	0 (18)	2 (18)
C. 133	,,	0	0	0	0	0	0
4558/1	,,	0	2	3	2	0	0
4558/4	,,	0	0	0	0	0	0
4640/4	,,	0	0	0	0	0	0
4697/4	,,	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)
46103/1	,,	0	0	0	0	0	0
46105/2	,,	0	0	0	0	0	1
46106/26	,,	0	0	0	0	0	0
46106/27	,,	0	0	0	2	0	0
4315/3	,,	0	0	0	0	0	1
4332/2	,,	7	6	7	7	9	9
C. 117	,,	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)
CP. 175	,,	0	0	0	0	0	0
4556/3	,,	0	0 (19)	0 (18)	0 (18)	0 (18)	0 (17)
4568/3	,,	1 (17)	2 (19)	2 (19)	1 (18)	1 (18)	1 (17)
4318/22	,,	0	0	0	0	0	0
C. 56	Cassava x M.	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)
C. 136	Glaziovii	0	0	0	0	0	0
CP. 184	,,	2	2	2	2	0	0
4558/3	,,	0	0	0	0	0	0
4598/1	,,	0	0	0	0	0	0
46240	Cassava x M. dichotoma	0	0	0	0	0	0
4239/2	Cassava x "Tree" Cassava	0	1	2	1	3	0
TP. 186	,,	0	0	0	0	0	0
T. 251	,,	1	6	6	5	0	0
T. 220	,,	0 (14)	0	0	0	0	0
T. 551	,,	0	0	0	0	0	1
Alpin Valenca	Ordinary Cassava			All primary infection			
Msitu	,,	0	0	0	0	1	1
B. 15	,,	0	0	0	0	0	0
F. 100	,,	0	0	0	0	0	1
37244E	,,	0	0	0	0	0	0
37318A	,,	4 (16)	5	5	6 (19)	6 (19)	10 (19)
4029/17	,,	0	0	0	0	0 (19)	3 (19)
Binti Minsi	,,	0	0	0	1	1	0
Sareso	,,	4	4 (19)	4	4	2 (19)	6 (19)
C. 756 B (*a*)	,,	1	1	1	2	2	0
F. 279	,,	0	0	0	2	3	4
37312E	,,	0	2	2	1 (19)	1 (19)	1 (19)
4026/20	,,	0	0	0	0	1	1
Malindi Fine Leaf	,,	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)	0 (19)

NOTE.—Where plants are missing in the plots, the total number of remaining plants has been inserted in brackets. A few of the early misses were replanted.

These clones have remained remarkably free from mosaic at Matuga in comparison with a certain number of the same clones at Gombato Estate. There infection is many times more severe and the resistance of many clones appears to have broken down completely.

Table II gives a summary of the results from some of the same clones from Gombato Estate. These clones were planted out in April, 1951.

TABLE II.—RESISTANCE TO MOSAIC OF CASSAVA CLONES PLANTED AT GOMBATA ESTATE (PERCENTAGE OF INFECTED PLANTS OUT OF 200)

VARIETY	At 8 months	At 11 months	At 14 months
4315/3	0	0	0
C. 117	17	15	22
4318/22	0	0	0
C. 56	14	14	25
C. 136	0	0	23
CP. 184	0	10	12·5
4558/3	9	4	26
4598/1	0	0	0
T. 220	7	2	1
TP. 186	5	1	0
Alpin Valenca	45	—	50
Msitu	56	—	100
B. 15	55	50	61
37244E	6	5½	25
37318A	28	24	35
4029/17	25	17	34
C. 756B (*a*)	63	56	69
37312E	30	28	30
4026/20	3½	3½	13
Binti Minsi	67	—	—

NOTES.—(*a*) The percentage mosaic is recorded as generally less at the 11 months' period due to the severe defoliation at the end of the dry season removing symptoms. The same tendency can be noted in Table I where the 10 months' count was taken in March but in this instance defoliation was not so severe.

(*b*) The clones at Gombato were grown in adjacent, approximately ¼-acre plots; not between hedges of local diseased material as at Matuga.

The reasons why there should be this remarkable difference between the resistance of some clones at Matuga and Gombato is not properly understood. Undoubtedly the infection at Gombato is more massive. Since the hedge material for the Matuga trial includes a considerable amount of plants from the Gombato area it is thought that any strains of the virus from that area, different from these at Matuga, would have been introduced. The breakdown of resistance at Gombato has been much greater than at other centres such as Amani or at a centre on the Tanganyika coast where some of these same strains have been tried. (1) More information should be available from the disease resistance trial which has recently been laid down with a wider selection of clones at Gombato by E.A.A.F.R.O. workers.

Observations on brown streak resistance of a number of clones planted at Gombato

Observations on the incidence of brown streak on a number of Cassava clones planted at Gombato were made when plants were being lifted in the yield and maturity trial (*See* section (b)).

Table III gives the percentage of roots infected by the disease at the final 23 months' period together with remarks on the severity of the attack in the roots showing symptoms. For each observation in both these tables, the roots of ten plants were examined.

(1) Information given by Mr. Jennings, Research Officer, E.A.A.F.R.O.

TABLE III.—BROWN STREAK STATUS OF CASSAVA CLONES GROWN AT GOMBATO ESTATE IN ¼-ACRE (APPROX.) PLOTS

Variety	% Roots with Brown Streak	Severity of Symptoms
23-Month Period		
4315/3	0.0	—
C.117	3.8	Slight
4568/3	0.0	—
4318/22	10.2	Slight
C.56	0.0	—
C.136	15.2	Slight
CP.184	2.0	Slight
4558/3	11.8	Severe
4598/1	38.2	Slight
TP.186	97.0	Very Severe
T.251	9.4	Slight
T.206	62.7	Severe
T.220	7.6	Slight
Alpin Valenca	82.5	Severe Mottling
B.15	22.0	Severe
F.100	8.9	Medium
37244E	16.0	Medium
37318A	13.7	Slight
4029/17	35.5	Slight
C.756B (*a*)	73.0	Very Severe
37312E	10.2	Slight
4026/20	56.2	Medium

Note.—Genetic origin given in Table I.

(*b*) PRELIMINARY OBSERVATIONS OF THE INCREMENTS OF YIELDS AT DIFFERENT PERIODS OF MATURITY AND EXAMINATION OF THE RATIO OF TOPS TO ROOTS OF A NUMBER OF CASSAVA CLONES GROWN AT GOMBATO ESTATE.

The clones of cassava listed in Table IV were planted in adjacent plots at Gombato Estate in April, 1951. Most of these plots were approximately ¼-acre in size, but some were much smaller. It was first decided to lift a quarter of each plot at 9, 12, 18 and 24 months in order to study the increments of yield at the different periods of maturity. As the management of the estate is more interested in a 15-month crop in particular, and shorter term crops in general, it was decided at their request to reduce the number of plants per lift after the 12-month one and have extra lifts at 15 and 21 months. The number of plants used for the assessment of the yield is included in brackets in Table IV. The lifting procedure was as follows: Ten plants were selected at random and the tops and roots weighed. (The roots of these ten plants were examined for brown streak. *See* previous section). Then the remainder of the plot was lifted and the remaining roots weighed. The separate root weights from the ten plants and the remainder were totalled and the average weight per plant determined. A miss was counted as a plant for the purpose of assessing the average weight per plant. The planting distance of the plants in all plots was 4 ft. by 4 ft. When, therefore, the average weight per plant is known the yield/acre under field conditions can be fairly accurately estimated. In every lifting an outer guard row was discarded.

TABLE IV.—WEIGHT/PLANT OF CASSAVA AT DIFFERENT PERIODS OF MATURITY

VARIETY	December, 1951		April, 1952		July, 1952		October, 1952		January, 1953		March, 1953	
	Average weight plant at 8½ months		Average weight plant at 12 months		Average weight plant at 15 months		Average weight plant at 18 months		Average weight plant at 21 months		Average weight plant at 3 months	
	From 10 Plants	Total Average	From 10 Plants	Total Average	From 10 Plants	Total Average	From 10 Plants	Total Average	From 10 Plants	Total Average	From 10 Plants	Total Average
4315/3	6·3	—	5·5	4·4(32)	6·2	5·3(20)	8·1	—	9·0	—	12·6	—
C. 117	3·8	3·9(100)	3·1	2·9(100)	5·8	4·9(50)	3·3	4·0(42)	9·7	6·7(66)	10·6	7·3(40)
4568/3	4·8	4·0(100)	3·2	2·2(100)	5·4	4·9(50)	4·9	3·8(38)	6·5	5·3(57)	4·0	3·3(40)
4318/22	2·3	1·7(50)	3·2	1·9(40)	3·0	3·1(20)	4·3	2·0(55)	7·7	5·8(22)	6·9	6·6(30)
C. 56	4·0	2·7(90)	3·0	2·2(90)	6·2	5·7(50)	6·2	7·4(40)	—	12·3(20)	11·4	—
C. 136	5·8	4·3(100)	5·5	4·2(100)	3·4	—	7·6	6·1(44)	10·4	9·0(44)	8·2	6·4(40)
CP. 184	4·0	3·7(100)	3·3	3·0(70)	6·6	2·2(50)	3·8	4·2(40)	9·1	3·9(57)	6·4	—
4558/3	5·5	3·1(100)	5·7	2·2(100)	5·8	4·0(50)	1·8	0·61(40)	4·0	2·0(50)	5·1	3·7(40)
4598/1	4·3	4·0(100)	3·5	1·8(100)	7·3	4·0(50)	6·2	5·9(50)	11·0	—	9·8	9·8(40)
TP. 186	2·3	2·7(90)	3·8	3·0(90)	4·6	4·5(50)	5·7	4·9(38)	4·1	5·4(54)	4·4	4·3(40)
T. 251	3·4	4·1(100)	4·0	2·6(100)	5·0	5·3(50)	4·5	4·4(44)	6·3	5·3(44)	5·0	5·6(40)
T. 206	5·7	5·5(100)	6·0	4·4(90)	8·6	6·7(50)	4·4	6·0(44)	10·2	7·3(44)	8·6	6·2(40)
T. 220	4·6	—	3·2	1·7(100)	6·6	6·1(50)	3·2	5·7(44)	8·3	10·9(44)	12·4	12·4(40)
Alpin Valenca ..	4·2	4·9(100)	7·8	5·7(90)	8·1	5·6(50)	10·0	7·7(44)	10·9	7·0(44)	10·7	—
B. 15	1·9	2·4(40)	2·5	3·0(40)	6·5	—	5·6	8·5(20)	—	—	9·5*	—
F. 100	2·3	2·1(40)	1·2	1·4(100)	4·8	5·2(20)	8·9	—	9·8	4·5(46)	12·5*	—
37244E	3·4	3·1(50)	3·0	2·7(30)	6·4	6·0(20)	6·1	—	3·6(12)	3·6(12)	6·1	—
37318A	4·1	3·6(20)	5·1	4·3(30)	8·6	8·5(20)	8·8	—	9·7(12)	9·7(12)	8·6	—
4029/17	2·2	1·6(100)	1·5	1·1(100)	4·0	3·4(50)	3·7	4·2(42)	3·9	2·9(42)	4·0	4·2(40)
C. 756B (*a*)	5·0	4·6(100)	7·8	6·0(85)	9·2	5·7(50)	7·5	5·5(44)	9·1	—	6·2	4·9(40)
37312E	4·0	4·0(100)	7·0	6·4(100)	6·1	8·1(50)	10·4	10·6(42)	11·4	9·7(44)	9·5	8·4(40)
4026/20	3·3	—	4·6	2·9(100)	4·0	3·5(50)	6·3	5·2(50)	5·0	7·0(20)	7·7	7·0(30)

* Outside plants as only single row left.

Rainfall was good up to December, 1951. From then on very dry conditions prevailed until the completion of the observations. This fact probably to a considerable extent accounts for the very poor increments of yield and the generally disappointing results. Misses in the plots were on the whole few. Nevertheless, it is interesting to note that in general the average weight per plant comes down sharply when a larger number of plants are used in the estimation of the weights and misses are counted as plants. When this Table IV is compared with Table III it will be seen that some of the better yielders are most susceptible to brown streak, and would be unsuitable for that reason.

Proportion of Tops to Roots

In Table V the results of a study of the ratio of weights of cassava tops to roots for the varieties listed are given. As already stated, 10 plants selected at random were used to obtain the individual weights and the weighings were done at 8½, 12, 18 and 24 months. The average weight/plant for each variety is set out alongside the ratio number for purposes of comparison.

The ratios given for each variety give a clear characterization of the variety as regards the amount of top growth in relation to roots. A comparison of the variety 4315/3 with TP.186 shows the wide range included in this test. The changes throughout the growing period are less clear but there is a general tendency for the ratio to increase up to 12 and even 15 months and thereafter to decrease. The change in the ratio is brought about in an increase in root growth as against top growth thereafter, although in some cases there is an absolute diminution in top growth, due mainly to die-back and defoliation. Generalizations are, however, difficult and each variety should be studied individually.

Palatability of the Clones

Palatability tests have been carried out on the varieties grown at Matuga. The following varieties have been classed as "good"—

Msitu, C.56 (if boiled in water), 4315/3, B.15, 37244E, 4026/20, 4558/3, F.279, T.206, 4332/2, 37318A, 4029/17, Alpin Valenca, 46106/27, 4239/2, 46103/1, 46240, 46105.

TABLE V.—RATIO OF TOPS/ROOTS AT DIFFERENT PERIODS OF MATURITY TOGETHER WITH AVERAGE YIELD PER PLANT FROM THE TEN PLANTS USED (*see* TABLE IV)

VARIETY	December, 1951		April, 1952		July, 1952		October, 1952		March, 1953	
	8½ Months		12 Months		15 Months		18 Months		24 Months	
	Ratio	Average Weight	Ratio	Average Weight	Ratio	Average Weight	Ratio	Average Weight	Ratio	Average Weight
4315/3	·37	6·3	·42	5·5	·35	6·2	·19	8·1	·27	12·6
C. 117	·92	3·8	1·42	3·1	·91	5·8	1·12	3·3	·48	10·6
4568/3	1·04	4·8	1·53	3·2	1·48	5·4	1·84	4·9	·95	4·0
4318/22	·96	2·3	·87	3·2	1·10	3·0	·65	4·3	·77	6·9
C. 56	·60	4·0	1·07	3·0	·89	6·2	·65	6·2	·58	11·4
C. 136	·53	5·8	1·22	5·5	1·15	3·4	·88	7·6	·71	8·2
CP. 184	—	4·0	1·85	3·3	1·52	6·6	1·53	3·8	1·22	6·4
4558/3	·76	5·5	·98	5·7	1·03	5·8	1·78	1·8†	·75	5·1
4598/1	1·25	4·3	2·23	3·5	2·33	7·3	1·29	6·2	·90	9·8
TP. 186	1·48	2·3	2·55	3·8	2·79	4·6	1·80	5·7	2·23	4·4
T. 251	·82	3·4	1·22	4·0	1·00	5·0	1·33	4·5	1·28	5·0
T. 206	1·30	5·7	1·83	6·0	1·57	8·6	2·50	4·4	1·50	8·6
T. 220	·28	4·6	1·16	3·2	·84	6·6	1·34	3·2	·45	12·4
Alpin Valenca ..	·95	4·2	·96	7·8	1·04	8·1	·85	10·0	·65	10·7
B. 15	1·31	1·9	1·12	2·5	·65	6·5	·82	5·6	·60	9·5*
F. 100	1·00	2·3	1·17	1·2	·88	4·8	·40	8·9	·49	12·5*
37244E	·80	3·4	1·27	3·0	1·41	6·4	·84	6·1	·98	6·1
37318A	·56	4·1	·67	5·1	·70	8·6	·29	8·8	·69	8·6
4029/17 ..	1·00	2·2	1·40	1·5	·95	4·0	·81	3·7	·90	4·0
C. 756B (*a*) ..	·74	5·0	·82	7·8	·76	9·2	·80	7·5	·60	6·2
37312E ..	1·12	4·0	·60	7·0	·89	6·1	·50	10·4	·72	9·5
4026/20	1·51	3·3	1·26	4·6	1·50	4·0	·86	6·3	·42	7·7

* See Table IV footnote. † Pig damage to root.

Fertilizers and Manures

Experiment 9/8/1/B.—Exploratory Fertilizer Trial

An exploratory fertilizer trial was laid down with the *object* of testing the responses of coastal soils to the application of different nutrients. The sites selected were Shimba Hills, Matuga, Kibarani and Gede. The Shimba Hills site is at about 800 ft. altitude, Matuga at 400 ft. and the remaining two at sea level. The trial commenced in the long rains, 1952, and will continue for several years. The design was a 3^3 factorial with the following treatments:—

1. *Nitrogen* (*N*)
   - N_0 = no sulphate of ammonia.
   - N_1 = 1 cwt. sulphate of ammonia per annum.
   - N_2 = 2 cwt. sulphate of ammonia per annum.
2. *Phosphate* (*P*)
   - P_0 = no phosphate.
   - P_1 = 1 cwt. double superphosphate per annum.
   - P_2 = 2 cwt. double superphosphate per annum.
3. *Potash* (*K*)
   - K_0 = no potash.
   - K_1 = ½ cwt. muriate of potash per annum.
   - K_2 = 1 cwt. muriate of potash per annum.

All the fertilizers were broadcast. The long rains crop was Dwarf Hegari Sorghum and the short rains crop cowpeas. There was no reapplication of fertilizers for the short rains crop. The plot size used was 1/40-acre except at Gede, where a plot size of 1/80-acre had to be used because of scarcity of land. In both the long rains and short rains rainfall during growth was low at all centres but was appreciably higher at Shimba Hills than elsewhere. The following is a summary of results for the long rains crop:—

(i) Shimba Hills

The response to phosphate was highly significant.

	P_0	P_1	P_2	Mean	Standard Error
Mean yield in lb. per plot	31.3	78.8	83.5	64.5	4.11
Mean yield in cwt. per acre	11.2	28.3	30.7	23.0	1.46

The variance ratio for nitrogen just failed to reach significance.

	N_0	N_1	N_2	Mean	Standard Error
Mean yield in lb. per plot	55.0	65.3	73.4	64.5	4.11
Mean yield in cwt. per acre	19.6	23.3	26.2	23.0	1.46

There were no other responses.

(ii) Matuga

The response to phosphate was significant.

	P_0	P_1	P_2	Mean	Standard Error
Mean yield in lb. per plot	21.3	31.4	38.3	30.3	3.14
Mean yield in cwt. per acre	7.5	11.2	13.7	10.8	1.12

There were no other responses.

(iii) Kibarani

No significant responses.

(iv) Gede

No significant responses.

In the short rains the trial was replanted with cowpeas to test residual effects of fertilizers. Seeding at all centres except Gede, where a truly erect cowpea was used, was very bad, particularly so at Matuga. At Shimba Hills and Matuga it was obvious that very little useful information would be obtained from weighing the scanty amount of seed produced. It was therefore decided to try to get information from the weights of haulms. These weighings are subject to large error through variable moisture content. Nevertheless it is thought that the results obtained give some clear idea of the responses. The summary of results is as follows:—

(i*a*) SHIMBA HILLS

Seed.—No significant response to any treatment reflected in the seed weights.

Haulms.—Response to phosphate highly significant.

	P_0	P_1	P_2	Mean	Standard Error
Mean yield in lb./plot ..	31.0	89.7	109.8	76.8	9.5
Mean yield in cwt./acre ..	11.1	32.0	39.2	27.4	3.4

No other significant responses.

(ii*a*) MATUGA

Seed.—Seed negligible and not weighed.

Haulms.—Response to phosphate highly significant.

	P_0	P_1	P_2	Mean	Standard Error
Mean yield in lb./plot ..	133.9	182.7	194.6	170.4	9.10
Mean yield in cwt./acre ..	47.8	65.2	70.6	60.9	3.25

No other significant responses.

(NOTE.—Higher yield of haulms at Matuga than at Shimba Hills due to varietal difference.)

(iii*a*) KIBARANI

No significant responses to any treatments.

(iv*a*) GEDE

No significant responses to any treatments.

The main picture is one of high responses to broadcast superphosphate at Shimba Hills and to a lesser extent at Matuga, and this phosphate has shown a good residual effect at both places. The use of 1 cwt. of double "supers" appears to be the most economic application. At Gede and Kibarani there is no apparent response to phosphate. However, in the eyescoring of the plot at Kibarani there appeared to be a small response to phosphate in the vegetative growth of the cowpeas. It has not been reflected in the seed. At Shimba Hills the response to nitrogen was just apparent. Nitrogen has been without significant effect elsewhere. Potash has given no response at any centre.

Tie-ridging, Mulching and the Application of Farmyard Manure

EXPERIMENT 9/13/1

A 2^3 factorial experiment, with four replications, was started in the long rains, 1952, at the three sites, Matuga, Shimba Hills and Gede, to test the effects of tie-ridging, mulching and the application of farmyard manure, the treatments being:—

(*a*) 3-ft. ridges tied every 3 ft. (R) versus flat.

(*b*) 10 tons of farmyard manure (M) versus nil.

(*c*) A mulch of dried grass (X) versus nil.

The manure was applied broadcast and, on appropriate plots, ridges were subsequently made up by hand. Plot size was 1/40th-acre. At all sites Dwarf Hegari Sorghum was planted in the long rains, followed by cowpeas in the short rains. Rainfall in both seasons was low at all centres but at Shimba Hills it was higher than elsewhere during the long rains.

The main results obtained in the long rains may be summarized as follows:—

(*a*) *Shimba Hills.*—A significant increase in the yield of grain resulted both from ridging and from the application of farmyard manure and there was a significant positive interaction between these treatments, as indicated in the table below. The response to mulch just failed to reach significance.

Mean Yield of Grain, lb. per Plot

	Flat	Ridged	Mean
No manure	18.4	29.9	24.1
Manure	57.0	81.4	69.2
Mean	37.7	55.6	46.7

(Least significant difference 5.96 ($p = 0.05$), 8.17 ($p = 0.01$).)

(*b*) *Matuga.*—Owing to severe damage by grain eating birds, grain yields were of no value but the yields of straw were recorded and the effect of the treatments compared on this basis. Farmyard manure significantly increased yields, the response to the ridging just failed to reach significance, and mulching had no effect.

Mean Yield of Straw, lb. per Plot

	Flat	Ridged	Mean
No manure	87.7	116.7	102.2
Manure	140.3	151.1	145.7
Mean	114.0	133.9	124.0

(Least significant difference 20.69 ($p = 0.05$), 27.09 ($p = 0.01$).)

(*c*) *Gede.*—Farmyard manure significantly increased the yield of grain but there were no other responses.

Mean Yield of Grain, lb. per Plot

No manure	Manure	Sig. diff. ($p = 0.05$)	Sig. diff. ($p = 0.01$)
20.3	28.4	5.00	6.86

At the Shimba Hills, where the rainfall was highest, the response to ridging is clear; at Matuga the rainfall was unusually low and it is thought that in a more normal season the response to ridging would have reached significance; on the very sandy soil at Gede the ridges dried out very rapidly. The amount of mulch applied at all sites, both in this season and also for the short rains, was probably inadequate.

For the short rains farmyard manure was not re-applied and the ridges were not split and re-made but merely moulded up. On the mulched plots the stover from the long rains crops was added to the mulch but on other plots it was removed as it could not have been incorporated in the soil without affecting the treatment comparisons and there was little likelihood of it rotting down during the short dry period between harvesting and planting the short rains crop.

At Matuga and the Shimba Hills the cowpeas planted turned out to be a spreading variety and, at the spacing used, the vegetative growth was too dense to permit more than sparse seeding especially on the manured plots, where growth was most vigorous. Consequently, comparisons had to be based on haulm weights

and on scoring the plots for vegetative growth during the season. At the Shimba Hills the only significant response was to the residual effect of farmyard manure. From the scoring there appeared to be a beneficial effect from mulching in producing rather more vigorous growth of darker colour, but the response in yield of haulms failed to reach significance.

SHIMBA HILLS, MEAN YIELD HAULMS PER PLOT LB.

No manure	Manure	Sig. diff. (p = 0.05)	Sig. diff. (p = 0.01)
203.7	418.1	56.7	77.6

At Matuga there were significant responses both to the residual effect of farmyard manure and also to mulching.

MATUGA, MEAN YIELD HAULMS PER PLOT LB.

	No mulch	Mulch	Mean
No manure	38.5	65.4	52.0
Manure	94.0	110.2	102.1
Mean	66.2	87.8	77.0

(Least significant difference 14.89 (p = 0.05), 20.40 (p = 0.01).)

At Gede there was no significant response to any treatment but here again, observations during growth indicated a benefit from mulching and the response to this treatment in haulm yields only just failed to reach significance.

Fodder Crop Observation Plots

EXPERIMENT NO. 11/1

Observation plots were established at the Shimba Hills with the object of finding the most suitable crop, or mixture of crops, for dry season fodder production and observing the effect of phosphate and farmyard manure on the growth of such crops. Napier grass, perennial Kavirondo sorghum, and *Panicum maximum* were grown, alone and in mixture with *Dolichos* sp. ex Kilima Kiu, cowpeas or velvet beans. *Dolichos* was poor but the other two legumes appeared to increase the total weight of fodder during the long rains. Napier grass produced easily the greatest bulk and perennial Kavirondo sorghum gave the poorest results. An application of 2 cwt. per acre of double superphosphate gave a big increase in yield and so did 10 tons of farmyard manure, but its effect was not as great as that due to phosphate.

Observation Plots of Ley Species

EXPERIMENT NO. 13C/1

Small observation plots, each 1/20th-acre in size, were established at Matuga and the Shimba Hills. The following species have been used:—

(P = Planted; S = Sown)

SHIMBA HILLS

Erect Star Grass, P
Creeping Star Grass, P
Molasses Grass, S
Eragrostis curvula, S
Pemba Grass, P
Eragrostis superba, S
Cenchrus ciliaris, S
Panicum deustum, P
Panicum makarikariensis, P

MATUGA

Erect Star Grass, P
Creeping Star Grass, P
Molasses Grass, S
Pemba Grass, P
Cenchrus ciliaris, S
Panicum deustum, P
Panicum makarikariensis, P

To date the most promising grasses have been Molasses grass and Erect Star grass, the Molasses grass enjoying the further advantage of being a sown grass. *Cenchrus ciliaris* has grown well at both sites. Other grasses which have grown well but which look less promising for performing the functions of a temporary ley are *Eragrostis curvula, Eragrostis superba,* Pemba grass and *Panicum makarikariensis. Eragrostis curvula* is a very hard grass of doubtful palatability. *Eragrostis superba* seems to be quickly ousted by other useless species such as *Eragrostis ciliaris.* Pemba grass and also *Panicum makarikariensis* produce little bulk. Creeping Star grass and *Panicum deustum* appear completely unsuitable.

Exploratory Ley Establishment Trial

EXPERIMENT No. 13D/34

A 2⁴ factorial exploratory trial on ley establishment with the following treatments was begun at the Shimba Hills in the long rains.

(*a*) Two species: Planted Erect Star grass versus sown Molasses grass.

(*b*) Nurse crop: Nurse crop Dwarf Hegari sorghum versus nil.

(*c*) Cultivation: 3 ft. tied ridges versus flat.

(*d*) Manure: 10 tons per acre versus nil.

The Molasses grass was sown in rows 6 in. apart and the Star grass was planted in rows 1 ft. apart and 1 ft. between plants in the rows. The Molasses grass did not germinate for several weeks which badly upset the trial. The seed may have been freshly harvested and again, although surface planting was aimed at, it may have been put in too deep. These two factors could account for the delay in germination. In the end the Molasses grass established itself very well. The following points stood out:—

(i) Both Molasses grass and Erect Star grass established themselves reasonably well under all treatments.

(ii) Better establishment was achieved where manure was used.

(iii) The nurse crop of Dwar Hegari sorghum, planted in rows 3 ft. apart, appeared to slow down the progress of the Star grass, but the latter came away equally as well as where it was planted without a nurse crop when the Dwarf Hegari sorghum was harvested.

Observation Plots of Short-term Varieties

EXPERIMENT No. 15/1/A

Observation plots were again established at Matuga and Kibarani with the object of finding a short-term maize variety suitable for the uncertain rainfall conditions of the coast. The following varieties were tried:—

90-day, 90-day ex Nyasaland, Chester County, Chester County ex Nyasaland, Wisconsin White Dent, Wisconsin White Dent ex Nyasaland, British Honduras, British Honduras ex Nyasaland, South African Yellow Flint, South African Yellow Dent, South African White Flint, South African White Dent, Early Pearl, Local White, Local Blue, Local Red, Local Durum.

The varieties S.A. Yellow Flint, S.A. Yellow Dent, S.A. White Dent, Wisconsin White Dent and Wisconsin White Dent ex Nyasaland were all very poor and not worth further trial. The only introductions which are in the same yield and suitability class as the best local strains, i.e., Local Durum, Local White Grain and

Kibana Blue are the varieties 90-day ex Nyasaland, Chester County ex Nyasaland and British Honduras ex Nyasaland. 90-day and British Honduras did quite well at both centres and Chester County did well at Matuga. Early Pearl was of medium quality and deserves a further trial.

Groundnuts

EXPERIMENT NO. 18/D/1.—SELECTION OF WILT RESISTANT GROUNDNUTS

The object of this work (which is being carried out at Matuga) is to select groundnuts resistant to Fusarium Wilt. Work was started in 1951 when the first selections were made in material grown in the Coast Province. Rows of seed, the progeny of a single selected plant, were planted out for observation. In addition, small areas were planted up with bulk seed collected from Kilifi district from which further selections could be made.

Results to date have been disappointing. The main difficulty in 1952 was that it proved extremely difficult to distinguish wilt resistant plants if they were present since due to drought and insect attack all groundnuts were wilted. Insect attack by *Dasus simplex* was severe. Many of the nuts produced were without kernels, probably due to a combination of drought and insect attack. As a result very few seeds are available for the continuation of the original selections. However, enough seed is available from the best selections to carry on the lines. Further selections have been made in Kwale district during the year for planting out progeny rows in 1953.

Sorghum Observation Plots

EXPERIMENT NO. 27/1

Observation plots were again planted at Matuga and Kibarani in an attempt to find good, high yielding, palatable and disease resistant, short-term sorghum varieties suitable for coastal conditions.

The varieties used in the 1952 trials were—Bird-proof, Hegari, Pink or Red Kaffir Corn, Feterita, Mixed Kaffir Corn, White Kaffir Corn. Those showing promise were Bird-proof, Feterita and Hegari. Bird-proof gave an attractive stand with vigorous growth and was to some extent resistant to attacks of grain-eating birds at Matuga. Its drawback is that it is no more palatable than the ordinary Dwarf Hegari sorghum. If, however, it continues to exhibit resistance to bird damage, it will thus enjoy a very great advantage over the commonly grown variety. Feterita had a good robust growth with an attractive large white grain. It was the tallest of the introductions, growing to 6 ft. to 7 ft. Hegari produced a crop up to the standard of Dwarf Hegari in yield, has an attractive whitish grain and is classified as sweet, making it more palatable than Dwarf Hegari. However, it is very attractive to the grain-eating birds.

Of 24 varieties of sorghum tried over the past two years at the Coast, the only three showing promise are Bird-proof, Feterita and Hegari.

Sugar

EXPERIMENT NO. 29/3.—FERTILIZER TRIAL

After a preliminary uniformity trial in 1951, a fertilizer trial was begun this year at Ramisi Estate. It is of 3^3 factorial design with the following treatments:—

Sulphate of ammonia at 0, 2 and 4 cwt. per acre.
Muriate of potash at 0, 1½ and 3 cwt. per acre.
Single superphosphate at 0, 2 and 4 cwt. per acre.

The phosphate was applied at planting and the nitrogen and potash 23 days after planting.

The sugar cane could not be planted in the long rains owing to the severe drought. It was planted in the short rains on 1st December, 1952. A Don planter was used and a continuous line of cane was laid along the furrows after appro priate plots had applications of phosphate. Germination was satisfactory in this experiment despite the scanty rains. The sulphate of ammonia and muriate of potash was applied on 23rd December, 1952, and the experiment appears to be progressing satisfactorily.

Experiment No. 29/4.—Molasses and Filter Press Mud Combined With Nitrogen

A randomized block experiment with six replications was begun at Ramisi Estate to compare various rates of application of sulphate of ammonia, alone and in combination with filter press mud or molasses, the treatments being:—

N_0	N_0M	N_0F
N_3	N_3M	N_3F
N_6	N_6M	N_6F

N_0 = No sulphate of ammonia

N_3 = 3 cwt. sulphate of ammonia/acre.

N_6 = 6 cwt. sulphate of ammonia/acre

M = 3 tons Molasses per acre

F = 10 tons net weight filter press mud/acre

The molasses was applied on 14th August, 1952, on clean land and was then lightly ploughed in. The filter press mud was left heaped so that it would be sufficiently weathered for application in early December. However, the first lot of filter press mud was burnt inadvertently so that a new lot had to be weathered. This meant the postponement of the experiment until a dangerously late date. It was not until 9th December that the new lot of filter press mud was ready. Even at this date it was in a rather raw state having been weathered for only six weeks. The experiment was planted up on 10th December, the same method of planting being used as in experiment 29/3. The nitrogen was applied on 30th December in the furrows.

Experiment No. 29/6.—Herbicidal Weed Control

A 6 × 6 Latin square experiment was started at Ramisi Estate to investigate the use of herbicides in sugar cane, the treatments being:—

(i) Control.

(ii) Fernoxone, 2 applications as pre-emergent spray.

(iii) Y.F. 2618, 2 applications as pre-emergent spray.

(iv) Fernoxone, one pre-emergent application followed by P.C.P. Oil and Y.F. 2618 as post-emergent application.

(v) Fernoxone, one pre-emergent application followed by T.C.A. and Fernoxone as a post-emergent application.

(vi) Fernoxone and P.C.P. Oil as a post-emergent spray only.

The sugar cane was planted on 3rd December, 1952. Again the same method of planting was used as in the previous two experiments. The first application of the pre-emergent sprays was applied on 8th December. This application kept down the germination of all weeds except *Cyperus gracilininux* and *Cyperus pseudo hildebrandtii* which appeared to be unaffected by the spray. The second treatment of pre-emergents was applied on 2nd January before any of the grasses had

emerged. Results for these pre-emergent applications were very promising but the experiment was weeded in early February by the estate labour despite the precautions that were taken. As a result it will be necessary to repeat the experiment.

Cotton Variety Trial

Ten cotton varieties were compared in randomized block trials with eight replications at three sites, Matuga, Kibarani and Gede, the varieties being:—

N.17—(Control)	A.7233
S.47	A.7262
A.618	A.7266
A.619	A.794
A.7217	A.798

The establishment of the crop was difficult at all centres owing to the very poor rains. At Matuga replanting of the trial was necessary and at Kibarani much supplying was necessary and the local control (N.17) had to be replanted later. At Matuga there was much seedling blight except on the local control. Growth was very poor throughout the trial. At Kibarani growth was much better. Seedling blight also occurred to a lesser extent here. At Gede the stand was very poor owing to drought but a reasonable crop was produced here on the surviving plants. The attack of bacterial blight was much less here.

The extent to which bacterial blight (*Xanthomonas malvacearum*) occurred this season indicates that a fair degree of resistance to this disease is necessary in any variety to be grown at the coast and for this reason all the varieties in the trials, except N.17 and S.47, will have to be discarded.

W. R. WRIGHT,
Agricultural Officer (*Exp.*).

ANNUAL REPORT ON EXPERIMENTAL WORK, RIFT VALLEY PROVINCE, 1952

Eldoret

Fertilizers

A residual fertilizer trial to test the effects of phosphates on grass, and subsequently on arable crops (Code No. 9/10), was laid out at Eldoret Experimental Farm. Its design is a 3^1 factorial in a single replication with 81 treatments being a combinations of:—

(*a*) *Phosphate at sowing time*: no phosphate, 10-cwt. Uganda rock and 144 lb./acre doublesupers.

(*b*) *Annual top-dressing*: with nil, Uganda Rock and doublesupers.

(*c*) *Nitrogen annual top-dressing*: no top-dressing, 60 lb. nitrogen as ammonium sulphate and 60 lb. nitrogen as sodium nitrate per acre.

(*d*) *Doublesupers to wheat following grass*: 0–1–2 rates (not yet decided).

The grass (Molasses) was undersown on 30th June, 1952, in 294M wheat (55 lb./acre) at a rate of 15 lb./acre, grass alternating with wheat in 7 in. rows. The Molasses will continue as such and clipping weights will be taken for three years followed by wheat as indicator crop. The Uganda Rock was broadcast on the 12th June, 1952, and the top-dressings of nitrogen broadcast on the 28th August, 1952. Wheat and doublesupers were drilled with the Planet Junior and the Molasses by hand. No clippings of Molasses were done in 1952, but observations showed a significant response of phosphate over no phosphate and the interaction nitrogen x phosphate was significant, in the growth of Molasses. It was very clearly shown that phosphate is essential for establishment of Molasses grass. With regard to wheat (harvested on the 17th December, 1952, but results have not been analysed yet) there is a clear response to doublesupers and a slight response to Uganda Rock, but the interaction nitrogen x phosphate is not significant. Uganda Rock seems to be more effective on Molasses grass than on wheat. Nitrogen alone had no effect either on Molasses grass or on wheat. No difference was noticeable between the effects of ammonium sulphate and sodium nitrate.

A co-operative experiment to determine the effect of various treatments on the alleged crop reduction after ploughing in straw (26/6) was laid out in Eldoret district at Eureka Estates, Sergoit. Three rates of sulphate of ammonia (0, 2 and 4 cwt./acre) were applied at three different times: at ploughing time, at sowing time, and half at ploughing time and half at sowing time. In addition, there were three times of breaking, after harvest (3rd January, 1952), at the beginning of the rainy season (5th April, 1952), and prior to sowing time (2nd July, 1952). Also there were three different treatments of the stubble: no burning, burning, and taking off straw. These 81 treatment combinations formed a 3^4 design, single replication (plot size 1/58th acre), and the whole experiment was sown to 294M wheat at 120 lb./acre with a basal dressing of 100 lb. doublesupers/acre. The experiment was harvested on 31st December, 1952, but results have not been analysed. However, observation and scoring of growth indicate an

increasing response to rates of sulphate of ammonia, which is independent of time of application. Treatment "burning" appeared to be better than "no burning" or "raking off straw".

Grasses

A ley establishment trial in six randomized blocks (Code No. 13D/33L), was laid out with 294M wheat undersown to an Nzoia Rhodes–Lucerne (Provence) mixture. Treatments were:—

(*a*) Wheat alone in 7 in. rows.

(*b*) Ley broadcast in pure stand.

(*c*) Mixture established under wheat, drilled in 14 in. rows.

(*d*) Mixture established under wheat, drilled in 7 in. rows.

The sowing rate for wheat was in all cases 82 lb./acre, Rhodes at 20 lb. and Lucerne at 5 lb./acre. A basal dressing of 1 cwt. doublesupers/acre was broadcast immediately prior to sowing and one of sulphate of ammonia at $1\frac{1}{2}$ cwt./acre was broadcast after emergence on 20th August. Wheat was mechanically planted on 1st July, and the mixture broadcast on the 3rd July.

This experiment was harvested on 19th December, but results of analysis are not available yet. The yields of seed and straw of pure wheat plots is significantly more than those of the undersown plots, but there is no such difference either in yields of seeed of wheat between the undersown plots, or in dry green matter yield of grass between any of the treatments concerned. The undersown wheat plots ripened a few days earlier than the pure wheat plots. At the time of harvest the grass on the undersown plots looked fresher and greener than the pure grass plots.

Lucerne was completely suppressed in the undersown plots and on the pure grass plots reached a height of 8 in. and then gradually disappeared. In the undersown plots of the luscious growth of the grass of up to $1\frac{1}{2}$–2 in. would have interfered with mechanical harvesting of wheat. A more suitable choice for undersowing of wheat would have been Molasses grass, or sowing of Rhodes might have been postponed until the wheat had reached a height of approximately one foot, and also the topdressing of ammonium sulphate could have been omitted or postponed until a year later. Probably Rhodes could find its place in a mixture with oats (silage) or maize.

Ol Joro Orok District

Fertilizers

A trial with barley with special reference to effect on malting quality was carried out at Ol Joro Orok Experimental Station. This experiment, a 3^3 confounded factorial, in two replicates, was planted on the 24th July, 1952, the treatments being:—

Doublesupers	0, 75, 150 lb./acre.
Ammonium sulphate	0, 25, 50 lb./acre.
Muriate of potash	0, 25, 50 lb./acre.

Results have not been analyzed yet, but observations show that again there is a response to phosphate this year, in spite of the fact that a very dry September held growth down overall.

Legumes

Four Sweet Lupin varieties were planted in observation plots at Ol Joro Orok. Only the Sweet Blue variety ex Heilbuth was successful, the other three, Yellow ex Heilbuth, Weiko and Colville, being a complete failure.

Pests and Diseases

A trial was carried out in conjunction with I.C.I. to see the effect of Mergamma insecticides on the black wheat beetle (*Heteronychus consimilis*). The design was four randomized blocks of seven plots each, planted on the 3rd July, 1952, and had the following treatments:—

Mergamma A at 2 oz. per 75 lb. seed/acre.
A at 4 oz. per 75 lb. seed/acre.
A at 6 oz. per 75 lb. seed/acre.

Mergamma B at 1 oz. per 75 lb. seed/acre.
B at 2 oz. per 75 lb. seed/acre.
B at 3 oz. per 75 lb. seed/acre.

Control (untreated).

Results have not been analysed yet, but the insecticides were effective, although the beetle did not appear in great numbers.

Weeds

A weed control experiment was laid out on the 15th July, 1952. Weed-killers were applied on the 12th August, 1952. The experiment was four randomized blocks of 17 plots each and the treatments, one Control, Agroxone 3, 2–4 D amine (Fernimine), 2–4D ester and Methoxone ester, each at four rates, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 lb. acre. Results have not been analysed, but of all materials 2–4 D amine seems most effective.

Nakuru District

Grass Trials at Rongai and Njoro

Identical unreplicated trials were planted in which three grasses, *Brachiaria brizantha, Panicum maximum,* and *Setaria sphacelata* ex Nandi, were sown either with *Dolichos* species ex Kilima Kiu or *Dolichos falcatus,* in 14 in. or 28 in. rows, and with the legumes either sown in the same row with the grasses or in alternate rows. The best results were obtained where the grasses and legumes were sown in alternate rows at the closer spacing, although the seed rate per acre was the same over all treatments. *Setaria* was much the most successful grass, both *Brachiaria* and *Panicum* germinating poorly but producing good individual plants.

A 7 × 7 Latin square experiment was started at Londiani to compare the productivity of the following grasses; Nzoia Rhodes grass, Rhodes grass ex Molo, Olsgaard Cocksfoot, *Setaria sphacelata* ex Nandi, Kentucky 31 fescue, *Brachiaria brizantha* and *Panicum maximum. Setaria* was quite outstandingly the best grass with *Panicum maximum* next in order of merit. Nzoia Rhodes was slow to get away but remained green in the dry weather longer than the other grasses. Molo Rhodes and *Brachiaria* were unsatisfactory due to poor growth. Cocksfoot and Kentucky fescue made relatively poor growth and it is probable that the altitude (7,000 ft.) is too low for these species.

In observation plots at Subukia (7,000 ft.) *Setaria* was again the best grass followed by Nzoia Rhodes and *Panicum maximum.* Kentucky fescue and Cocksfoot made comparatively poor growth and *Brachiaria* suffered from poor germination.

In a 4 × 2 × 2 factorial experiment started at Marindas, Cocksfoot was sown at four row spacings, 7 in., 14 in., 21 in. and 28 in; at two seed rates, 2 lb. and 4 lb. per acre; and with and without Subterranean Clover at 5 lb. per acre. The land was very foul with weeds, especially Spurrey and the 7 in. row spacing made it impossible to do effective weeding without damaging the grass. In the single cut during this season, the 14 in. spacing gave the highest yields.

A 6 × 6 Latin square clipping experiment at Marindas compares the productivity of Olsgaard Cocksfoot, S37 Cocksfoot, S26 Cocksfoot, S143 Cocksfoot, Kentucky 31 fescue and *Bromus marginatus*. *Bromus* gave the highest yield in 1951 but produced little this year and is beginning to die out. Olsgaard was the best of the Cocksfoots and Kentucky fescue has so far yielded less than any other grass.

Fertilizers

The results of a 3^3 factorial fertilizer trial at Marindas, with the factors (*a*) wheat, barley or oats; (*b*) Sulphate of ammonia at 0, 50 or 300 lb. per acre; (*c*) Sodaphosphate at 0, 200 and 400 lb. per acre, have not yet been analysed but there was a very marked response to phosphate particularly with barley.

Spraying

Two trials at Molo on the control of Spurrey in wheat indicated the best results were obtained with Agroxone 3 and Methoxone. Herbicides were also tried for the eradication of *Pavonia urens* from pastures in the Subukia area. The most successful material of those tried was Fernimine, but Agroxone 3 also gave good control. DNOC had an immediate adverse effect on the weed but after a lapse of about a month, recovery occurred and the weeds again grew strongly.

E. BOSWINKEL,
Agricultural Officer (*Exp*).

ANNUAL REPORT ON EXPERIMENTAL WORK IN CENTRAL PROVINCE, 1952

This report is divided into two parts: the first covering the work of the Agricultural Officer (Experiments), Machakos, Mr. V. R. S. Beckley, in the drier parts of the Province typified by that district, and the second dealing with the experimental work carried out under higher rainfall conditions by the Agricultural Officer (Experiments), Embu, Mr. H. B. Ambrose.

Machakos

A number of experiments of an exploratory nature were carried out at Makaveti, where climatic conditions, with an average rainfall of 33 in., are considered suitable for normal alternate husbandry, and at Kampi ya Mawe, which is situated within the Makueni Settlement area, where conditions are marginal for crop production and leys.

Makaveti

Work at Makaveti aims, firstly, at finding means of re-establishing a productive grass cover, either for permanent pasture or for temporary leys, on extensive bare, eroded areas; secondly, at the provision of dry season fodder for stock, and thirdly, at improved methods of arable crop production. The total rainfall for the year was 22.17 in., of which 13.84 in. fell in the long rains crop season and 7.59 in. during the short rains. Owing to the exceptionally heavy rains experienced in 1951 (53.1 in.), the crops during the long rains of 1952 were better than might be expected in view of the limited rainfall which occurred during the cropping season and the growth of established grass was good.

In the main ley establishment experiment, started in 1950, the chief purpose was to study the effects of various methods of preparatory cultivation, and of the application of farmyard manure, on the establishment of four ley "species"; two sown "species", Rhodes grass and a mixture of *Cenchrus ciliaris* and *Eragrostis superba,* and two planted species, Star grass and *Panicum makarikariensis.* The earlier results indicated that the best procedure for grass establishment is to plough and ridge the land, apply farmyard manure, and sow a mixture of the two local grasses, *Cenchrus ciliaris* and *Eragrostis superba,* at the beginning of the rains, following this with the planting of contour rows of Star grass at fairly wide intervals, so long as available labour and weather conditions permit. All the plots of the experiment had a satisfactory grass cover by the beginning of the long rains, 1951, and were grazed, when appropriate, during that year and in 1952. The amount of grazing obtained from the four "species" during the period from the beginning of the long rains 1951, to 27th September, 1952, was as follows:—

	Total beast days per acre	*Beast carried per acre per annum*
Rhodes grass	598.5	1.27
Cenchrus—Eragrostis	518.5	1.10
Star grass	470.9	1.00
Panicum makarikariensis ..	564.0	1.19

The *Cenchrus-Eragrostis* ley was established a season after the others as this seeds mixture was used to replace *Eragrostis curvula* which was originally included as one of the treatments but failed. The beneficial effect of farmyard manure was also reflected in the grazing figures.

The best procedure for grass establishment, as indicated by the above experiment, involves a good deal of labour and it cannot be expected that it will readily be adopted by the local farmers on the very extensive scale needed to rehabilitate the large areas of eroded land in the district. Consequently, it was considered desirable to find out if a somewhat simpler procedure could be found which would result in satisfactory grass establishment, and an observational trial has been started in which simple closure to grazing is compared with rough ploughing at intervals of 1, 3, 6 and 10 ft., combined with sowing the grass seeds mixture and/or planting Star grass. All plots were also split for the comparison of phosphate versus nil. It is too early yet to say whether any of the simpler preparations will prove satisfactory but it is already evident that it is necessary thoroughly to break the surface erosion "crust" on the soil and it appears that phosphate assists grass establishment. Similar indications have been obtained from an observational trial on the effects of various treatments in hastening natural regeneration of a grass cover, which began in 1950. In this trial no cultivation, scarifying, and ploughing and ridging were compared, and plots were split for the fertilizer treatments O, N, P and NP. There is already a good soil cover on all plots but whereas the uncultivated plots are still dominated by *Latipes senegalensis* and *Eragrostis ethiopica*, the better grasses, such as *Cenchrus ciliaris*, *Eragrostis superba*, Star and *Digitaria* are predominant on the cultivated plots.

A major difficulty experienced in work on ley establishment has been the uncertain germination capacity of the seed of local grasses, which has usually been low. An investigation has therefore been started into the effect of different times of harvesting and different periods of storage on this factor, in the course of which observations will also be made on damage to seed heads by fungus disease and insect pests.

A minor experiment in the sphere of ley establishment, which was carried out in 1951–52, comprised two Græco-Latin squares to compare the effect of four different nurse crops and four levels of application of farmyard manure on the establishment of Rhodes grass. In the unusually wet season of 1951 establishment was uniformly good and there was no significant effect of nurse crops, but application of faryard manure was markedly beneficial, as can be seen from the following figures for the first two cuts of the grass.

Yield of Rhodes Grass, dry matter, cwt. per acre

Tons Farmyard manure per acre	0	8	16	24	*Sig. Diff.* p=0·05	p=0·01
1st Cut	1·14	5·93	11·71	19·50	0·97	1·78
2nd Cut	19·19	26·47	37·14	37·57	1·46	2·53

The provision of dry season fodder for cattle is an extremely important matter in this area if stock are to be kept in good condition and the severe overgrazing and consequent erosion on grassland avoided. An exploratory experiment in the form of Græco-Latin squares was conducted in the short rains of 1951 to compare the yields of maize, bulrush millet, Improved Perennial Kavirondo

Sorghum and Sudan grass when grown for silage and to give some indication of the nutrient status of the Makaveti soil by the inclusion of the fertilizer treatments O, N, P and NP. The spacing of the fodder crops was not optimum in all cases but there was no doubt that maize and millet gave much higher yields than the other two crops.

Yield of green matter, tons per acre

Maize	*Millet*	*Sorghum*	*Sudan Grass*	*Sig. Diff. p=0.05*
11.55	10.18	5.10	2.87	0.25

There were also significant responses to phosphate and to nitrogen and the interaction between phosphate and nitrogen was positive and significant.

Yield of fodder, tons green weight per acre

	No Phosphate	*Phosphate*	*Mean*
No nitrogen	6.45	7.65	7.05
Nitrogen	6.41	9.19	7.80
Mean	6.43	8.42	7.42

Significant difference 0.25 tons (p=0.05)

With food crops an exploratory fertilizer experiment was started in the long rais, 1952, with maize as the crop, in the form of a 3^n factorial design the treatments being sulphate of ammonia, at 0, 1 and 2 cwt. per acre, double superphosphate at 0, 1 and 2 cwt. per acre, and muriate of potash at 0, $\frac{1}{2}$ and 1 cwt. per acre. Unfortunately, the maize which was planted rather late, scarcely yielded any grain and all fertilizers were broadcast, but there was an indication of a response to phosphate. The trial was continued in the short rains with reapplication of the fertilizers, phosphate being placed in the rows, and with bulrush millet as the crop. At the time of writing, the millet has not yet been harvested but there is a striking response to phosphate in growth.

Other experiments on food crops at Makaveti included a factorial trial to test the effect of ridging, mulching and application of farmyard manure, in which response to the latter was evident, together with variety trials on sorghum and beans.

Kampi ya Mawe

Work was begun at this small experimental station in 1952 to serve the needs of the drier, southern parts of Machakos District where conditions are either marginal for arable cultivation or clearly suited to ranching activities only. Typical of the former conditions is the greater part, if not the whole, of the Makueni Settlement area, where the indications are that the farming system should be based primarly on stock with only a minimum arable area, and where the problem of grass establishment is one of finding means of resting the small arable area under a productive ley. The still drier parts of the district, e.g. Simba-Emali and the Yatta, are ranching areas in which the problems requiring attention are grazing management and the control of bush encroachment in permanent pasture.

A factorial experiment on ley establishment was begun in the long rains in which the factors were, (*a*) planted Star grass versus sown *Cenchrus ciliaris*, (*b*) ridge versus flat cultivation, (*c*) 5 tons of farmyard manure per acre versus nil. Both species have been established, the Star grass so far being better than the *Cenchrus*, and there is evidence of a beneficial effect of farmyard manure, especially where its application was combined with ridging. Observation plots of several other ley species, including Rhodes grass, *Panicum maximum*, *P. makarikariensis* and *Eragrostis superba*, have been established. Work on dry season fodder crops was confined to the establishment of observation plots of Napier grass, perennial Kavirondo sorghum and maize, alone and in combination with spreading cowpeas or a *Dolichos* sp., and split for a comparison of the effects of no manure, phosphate or farmyard manure.

A fertilizer experiment and a trial to test the effect of ridging, mulching and application of farmyard manure, of identical design to the similar experiments at Makaveti, were begun. In the short rains the fertilizer trial is showing a marked response to phosphate. The other trial will not give any results this year owing to destruction of the crop by game.

Four long-term experiments have been begun in the Simba-Emali and Yatta areas to study methods of rotational grazing and bush control.

Embu District

Embu Experimental Station

This was the first season of experimental work at this new station, which is situated in the most important ecological zone of the Central Province, locally known as the "Star grass zone" but coming within the *Combretum-Hyparrhenia* area of D. C. Edward's map of the major vegetation types of Kenya. The altitude of the station is 4,600 ft., it has an average annual rainfall of approximately 42 in., and is on the Kikuyu red loam soil, being therefore typical of a large area of Central Province, at medium elevations, which is eminently suitable for alternate husbandry. The season proved to be an unfortunate one in which to initiate a programme of experimental work as in the first six months of the year the rainfall was the second lowest which has been recorded at Embu since 1910, when records were first begun.

Work on ley species comprised the establishment of observation plots of thirteen species or strains of grasses and five legumes and the establishment of a 6 × 6 Latin square clipping trial with grasses considered to be promising in the area, namely, Rhodes, Molasses, Star, *Panicum maximum*, *P. makarikariensis*, and *Cenchrus ciliaris*. In the latter trial establishment of all species except *Cenchrus* was satisfactory and molasses grass did particularly well.

An external experiment on methods of improving the carrying capacity of pastures largely dominated by useless bush and coarse *Cymbopogon* spp., which was started in 1950, was continued at three sites in Embu district. The treatments initially employed comprise, (*a*) rotational grazing alone, (*b*) removal of inedible material followed by rotational grazing, (*c*) as (*b*) plus application of 10 tons of boma manure, (*d*) clearing and planting Star grass, (*e*) as (*d*) plus application of 10 tons of *boma* manure. As may be seen from the table below, all other treatments continued to give considerably more grazing than rotational grazing alone, and where Star grass was planted the carrying capacity approached double that of the plots which were not cleared and planted. Since the beginning of the trial the difference between the manured and unmanured plots has gradually narrowed.

Number of grazing days per acre

Treatment	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
Baricho ..	130	375	420	905	852
Kinyori ..	168	425	393	749	628
Kianyaga	346	502	675	681	1,130
Mean, 1952	214	434	496	778	870
Mean, 1951	250	433	825	1,114	1,091*

*Plus a 10-ton hay cut at one site

A 3^3 factorial fertilizer trial, with the same levels of nitrogen, phosphate and potash as that at Makaveti, was begun but did not yield significant results although there was an indication of response to phosphate in the rather late planted crop of *Panicum miliaceum* which was used. A factorial experiment on ridging, mulching and the application of 5 tons per acre of farmyard manure showed a marked response to the manure and an indication of response to mulching but, in this dry season and on land newly broken, the unconsolidated ridges had an adverse effect on germination and gave lower yields than the flat plots.

Other work on arable crops included an experiment to compare ridge versus flat planting and two spacings with cassava, not yet completed, and observation plots of bean varieties, sorghum varieties and firbe crops, chiefly *Hibiscus* spp. A coffee variety trial is also in progress.

Experimental work is also conducted from Embu at three sub-stations representative of conditions differing considerably from those of the main station.

KIANJAKOMA

Kianjakoma, at 5,900 ft., is typical of the higher altitude "bracken zone", an extensive wet and coldish area on red or greyish volcanic soils at present largely dominated by bracken and used for little beyond rough grazing. Hitherto, crops have been singularly unsuccessful on this land and the grazing provided by the natural Kikuyu grass pasture is poor as, even where bracken is not present, the grass tends to deteriorate rapidly into an unproductive condition. A number of exploratory trials has been started with a view to finding the best means of eradicating bracken, of improving the Kikuyu grass pasture or replacing it with better grass, of ameliorating soil conditions so that food crops can be grown, and, also, with the object of finding cash crops suitable for the area.

The trial on bracken eradication and grass establishment is not at Kianjakoma but under similar conditions at another site in Fort Hall District. It compares various times of slashing bracken, followed by planting Kikuyu grass, either with or without cultivation and taking a maize crop, together with the application of phosphate or farmyard manure or both. No results are yet available. At Kianjakoma an unreplicated trial was begun to determine the effect of applications of 2 cwt. double superphosphate or 20 tons of farmyard manure, combined with surface scarification with fork *jembies*, on a deteriorated Kikuyu grass pasture. There has been a quick and beneficial effect from the manure, which was maintained until the end of the year, but no other responses. Small observation plots, each split for phosphate versus nil, were also established with a number of other grasses: Kentucky Fescue, Rhodes (local and Molo strains), Molasses, Star and *Panicum maximum*. Molasses and *Panicum maximum* have been strikingly successful and there has been a clear response to phosphate with all species.

An exploratory fertilizer trial in two randomized blocks was carried out to test the effect of nitrogen, phosphate, and farmyard manure alone and in all combinations, the crop being potatoes. There was a large response to farmyard manure, a lesser, but significant, response to phosphate, but no response to nitrogen and no significant interactions. The markedly beneficial effect of farmyard manure on arable crops was noted wherever this material was used.

As regards cash crops, a coffee variety trial has been started and there are observation plots of apples, pears, plums, peaches, tea and pyrethrum. Of the deciduous fruits only peaches have made satisfactory growth. Tea is successfully established and making good initial growth and pyrethrum, where manured heavily with farmyard manure, is doing well.

Molinduku

This sub-station is situated at an elevation of 3,800 ft. on sandy loam at the junction of the Kikuyu red loam and Basement Complex soils under the drier conditions (about 35 in. of rain per annum) of the "grass-woodland" zone, which is transitional between the *Combretum-Hyparrhenia* and *Acacia-Themeda* vegetative types. An exploratory fertilizer trial, with two replications of the treatments O, N, P and NP, showed a very clear response to phosphate in the growth of maize in the long rains and of bulrush millet in the short rains. Unfortunately, no grain was harvested in either season as the maize failed to set a crop owing to drought and the millet was taken by baboons, but yields of maize stalks showed a significant response to phosphate. Observation plots of ley grasses and of bean varieties, the testing of mosaic resistant cassavas were also carried out at this station.

Kabandore

This sub-station is also situated in transitional *Combretum-Hyparrhenia* and *Acacia-Themeda* country known locally as the *Acacia-Combretum* zone and conditions are similar to those at Makueni. Several small-scale experiments are in progress, including the testing of mosaic resistant cassavas and an exploratory fertilizer trial of the same type as that at Molinduku. In the latter trial, a response to phosphate was demonstrated both in the long rains crop of *Panicum miliaceum* and in the short rains crop of bulrush millet.

H. B. AMBROSE,
Agricultural Officer (Exp.)

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), NYANZA, 1952

Rainfall, 1952

	Kisumu	Kakamega	Kisii	Homa Bay	Kericho
January	2·33	0·30	0·91	Nil	1·53
February	2·00	4/72	4·29	Nil	3·90
March	6·09	3·05	7·88	7·85	2·88
April	15·79	12·46	10·33	8·62	16·77
May	9·64	12·97	9·21	11·20	11·87
June	1·69	5·36	4·81	3·80	1·55
July	1·75	12·54	8·00	2·27	7·04
August	2·01	7·06	7·07	2·08	7·20
September	2·48	8·57	6·60	3·44	6·01
October	0·62	5·39	7·46	4·53	7·79
November	1·49	3·72	2·47	2·64	1·97
December	Nil	0·86	0·83	0·27	1·16
TOTALS	45·89	77·00	69·86	46·70	69·67

Reports on Experimental Work

Bean Variety Trial (Ref. No. 2/2)

This trial was to test the yield of six varieties of beans (*Phaseolus vulgaris*) which had been obtained from the Scott Agricultural Laboratories. The trial was done at Kisii and at Homa Bay, as a randomized block experiment with approximately 1/40th-acre plots. The table below shows the mean yields obtained for each variety at each site:—

TABLE OF BEAN YIELDS (BAGS (200 LB.) OF DRY SHELLED BEANS PER ACRE)

Variety	*Kisii*	*Homa Bay*
Abundance	4.89	4.35
Navy Bean	3.48	3.30
Granada	2.91	4.15
Canadian Wonder	2.61	4.25
Tanganyika Large	2.01	3.40
Large White Kidney	1.97	3.90

At Kisii the variety Abundance gave a significantly higher yield than all other varieties. Navy Bean gave a significantly higher yield than Tanganyika Large and Large White Kidney. There was no significant difference between Granada, Canadian Wonder, Tanganyika Large and Large White Kidney. The Homa Bay yields were not tested for significance as only two replications were planted.

Cassava Variety Trial (4/1/2)

This trial at Kakamega was planted in 1951 with the object of testing the yields of six reputedly mosaic resistant varieties of cassava from Uganda at seven different harvesting dates and also to study the mosaic resistance and palatability of each variety. The design was three randomized blocks each containing seven plots for harvesting dates, each plot being split for the six varieties, with the split plot size 1/50.4 acre. The first harvesting date was at 12 months after planting, thereafter harvesting was at six-month intervals up to 48 months after planting. The first two harvests (at 12 and 18 months) were in April and December, 1952, respectively. The table below shows the yields obtained:—

TABLE OF CASSAVA YIELDS (LB. OF WASHED FRESH ROOT PER ACRE)

Variety	*1st Harvest*	*2nd Harvest*
Alpin Valenca	2,944.3	3,089.5
F.279	2,650.0	2,998.8
Msitu	1,969.6	2,504.9
37244E.	1,701.0	2,545.2
Kru	1,444.9	1,688.4
Binti Minsi	789.3	882.0
Sig. Dif. at 5 per cent	655.7	718.7

At the first harvest, the varieties Alpin Valenca and F.279 gave a significantly higher yield than the other four varieties. Binti Minsi yielded significantly lower than all other varieties. At the second harvest the varieties Alpin Valenca, F.279 37244E. and Msitu all significantly out-yielded Kru and Binti Minsi.

A palatability test was carried out on a number of Africans at Kakamega after the first harvest. They reported unanimously in favour of Binti Minsi, the lowest yielding variety.

The remaining five harvests will be in 1953, 1954 and 1955.

Fertilizer Trials (9/8/3)

These trials represent a continuation by the Department of the fertilizer work initiated by E.A.A.F.R.O. and carried out by them mainly in North Nyanza during the three previous seasons. During 1952 the trials were of two types (*a*) Exploratory, in areas where little or no fertilizer work had been done before; and (*b*) Rates and Placement trials in areas where the E.A.A.F.R.O. work had indicated phosphate and nitrogen responses.

Twenty-five exploratory trials were done, 12 of which were in the Southern Division of North Nyanza, five in the South-Western Division of Central Nyanza and four each in the Gulf and Southern Divisions of South Nyanza. Each trial was done on three crops, maize, sorghum and "wimbi", and there were four treatments —nil, N, P and NP, with a plot size of 1/242 acre. All the trials were observed and scored during growth and all except one of the 13 trials in Central and South Nyanza were harvested successfully, but only two out of the 12 North Nyanza trials were harvested, so that with these, fertilizer responses could only be judged by means of the scorings. On the information available, it appeared that there was a fairly general response to superphosphate in the Southern Division of North Nyanza, particularly with maize and sorghum, but responses to sulphate of

ammonia at a few sites only. The same remarks apply to the South-Western Division of Central Nyanza but with nitrogen responses rather more common. In the Gulf Division of South Nyanza the site on red soil showed a phosphate response, while the two sites on black soil showed a nitrogen response. In the southern division of South Nyanza there appeared to be no response to either of the fertilizers.

Rates trials comprising four rates of application of both superphosphate and of sulphate of ammonia in a 4 by 4 factorial layout with plot size 1/81.8 acre were carried out with maize at the following eight sites: Lugulu, Bungoma, Myango, Sangalo, Kavula, Bukura, Maseno and Kisii, all these sites except for the last two being in North Nyanza. Placement trials to compare drilling of phosphate versus broadcasting, combined with three rates of application of both phosphate and nitrogen in a 3 by 3 by 2 layout were carried out, also with maize at four sites: Lugulu, Sangalo, Bukura and Maseno. Large phosphate responses were obtained at Lugulu, Bungoma and Bukura but not at Myanga, Sangalo, Maseno or Kisii. It is felt that the Maseno result may have been influenced by the fact that very old seed was used which gave a very gappy stand, while at Kisii it is suspected that something must have gone wrong at planting time because other experiments on the Kisii farm in 1952 showed large phosphate responses as did exploratory trials by E.A.A.F.R.O. in the Kisii area in 1950. Nitrogen responses were shown at Bungoma and Sangalo only, and there appeared to be little or no benefit from drilling compared with broadcasting of phosphate at any of the four sites where this was tried.

"Wimbi" Tie-ridging and Manurial Trial (9/13/2)

This experiment was done at Kakamega and at Kisii, to study the effect of tie-ridging, farmyard manure and sulphate of ammonia on the yield of "wimbi".

Two-feet tie-ridges, tied every 2 ft. were compared with flat cultivation, combined with five tons per acre of farmyard manure versus nil, and with 1 cwt. per acre of sulphate of ammonia versus nil, in a 2 by 2 by 2 factorial layout, with plot size 1/48.4 acre. At both Kakamega and Kisii the flat plots gave a higher yield than the tie-ridged plots, and farmyard manure plots gave a higher yield than those without farmyard manure. These two results were statistically significant at Kisii but not at Kakamega. The table below shows the effect on yield of these two treatments at Kisii:—

TABLE OF "WIMBI" YIELDS (BAGS (200 LB.) OF DRY GRAIN PER ACRE)

Flat	5·5	F.Y.M.	6·6
Tie-ridged	4·5	Nil	3·1
Significant difference at 5 per cent	1·0	—	1·0

It was evident that at both Kakamega and Kisii, the small 2 ft. tie-ridges were unable to stand up to the heavy rainfall experienced in these areas. Work planned for 1953 will test large sizes of ridge.

Sorghum Tie-ridging, Manurial and Spacing Trials (9/13/3, 9/13/5 and 27/4)

A 2 by 2 by 2 factorial experiment at Kisii with sorghum (9/13/3) compared 2 ft. tie-ridges versus flat, F.Y.M. at 10 tons per acre versus nil and double superphosphate at 1 cwt. per acre versus nil. Plot size was 1/48.4 acre. Tie-ridging gave

a lower yield than flat cultivation but this result was not significant. Significant increases in yield were given by both F.Y.M. and phosphate as shown in the following table:—

TABLE OF SORGHUM YIELDS (BAGS (200 LB.) OF DRY GRAIN PER ACRE)

F.Y.M.	10·50	Phosphate	10·54
Nil	9·00	Nil	8·97
Significant Difference at 5 per cent	1·51	—	1·51

A 3 by 2 by 2 factorial experiment with sorghum at Kakamega (27/4) compared tie-ridging versus flat, double superphosphate at 1 cwt. per acre versus nil, and three different spacings of the crop— 2 ft. by 1 ft., 2 ft. by 2 ft. and 4 ft. by 2 ft. Plot size was 1/48.4 acre. Phosphate gave no apparent increase in yield but flat cultivation gave a significant increase in yield over tie-ridging, and 2 ft. by 1 ft. spacing gave a significant increase in yield over 2 ft. by 2 ft. spacing which in turn gave a significant increase in yield over 2 ft. by 4 ft. spacing (*see* table below):—

TABLE OF SORGHUM YIELDS (BAGS (200 LB.) OF DRY GRAIN PER ACRE)

		Spacing	
Flat	4·78	2x1 ft.	6·44
Tie-ridged	3·52	2x2 ft.	3·77
		2x4 ft.	1·26
Significant Difference at 5 per cent	0·75		0·96

A randomized block experiment with sorghum at Homa Bay (9/13/5) compared 6 ft. tie-ridges (with two rows of crop on each) versus 3 ft. tie-ridges (with one row of crop on each) versus flat cultivation. In addition plots were split for the manurial treatments O (Nil), M (farmyard manure at 5 tons per acre, P (double supers. at 1 cwt. per acre) and MP. Split-plot size was 1/42.5 acre. The analysis of the yields showed no significant treatment yields. The experiment is to be repeated in 1953 using cotton instead of sorghum.

Molasses Grass Establishment Trials (13 D/26)

Two such trials were laid down at Kakamega, one using maize as a nurse crop and comparing "early" versus "late" sowing of the grass, "normal" versus "close" spacing of the maize nurse crop, broadcasting versus drilling of the grass and 1 cwt. per acre of double supers. versus nil. The design was a 2^4 factorial. The other trial used sorghum as the nurse crop and had similar treatments with the addition of an extra pair—five tons of farmyard manure per acre versus nil, the design of this trial therefore being a 2^5 factorial. Plot size in the maize experiment was 1/96.8 acre, in the sorghum one 1/40.3 acre. In both trials "early" planting of the grass meant planting when the nurse crop was about 1 ft. high, late planting when 3 ft. high. "Close" spacing of both nurse crops was 2½ ft. by 9 in. while "normal" spacing of maize was 4 ft. by 1 ft., and of sorghum 3 ft. by 2 ft.

Establishment studies on these two experiments will be completed by means of sample cuts to be taken in 1953, but preliminary information from visual observations may be noted here. In the trial using maize as the nurse crop the

establishment of molasses grass appeared to be benefited by the following factors: "early" planting of the grass; "normal" spacing of the nurse crop; broadcasting of the grass. Phosphate did not appear to have any noticeable effect on establishment. In the trial using sorghum as the nurse crop, observation was rendered difficult and unreliable by a very heavy weed growth, the only observable result being a possible advantageous effect of "early" planting on establishment.

Exploratory Ley Establishment Trials (13 D/34 (*b*))

These trials at Kakamega and Kisii were to study the establishment of four grasses, Molasses, Rhodes and Pemba grass (*Stenotaphyrum dimidiatum*) at both stations, with in addition *Paspalum dilatatum* at Kakamega, and *Brachiaria brizantha* at Kisii. A maize nurse crop was used in both trials and additional treatments were 5 tons per acre of farmyard manure versus nil, and 1½ cwt. per acre of double superphosphate versus nil. The design was therefore a 4 by 2 by 2 factorial. In addition, at Kisii the phosphate treatment was split for two times of application, (*a*) at time of planting the nurse crop, and (*b*) at time of planting the grasses. The molasses grass and Rhodes grass were sown in drills 2 ft. apart, the other grasses being planted vegetatively in 2 ft. rows, 6 in. apart in the rows, when the maize was about 1 ft. high. The maize nurse crop was spaced 4 ft. by 1 ft.

Establishment studies on these two trials will be completed by means of sample cuts to be taken in 1953 but preliminary information from visual observations may be noted here. In the Kisii trial, Rhodes grass and Pemba grass establishment was good and appeared to be improved by farmyard manure. Molasses grass and *Brachiaria brizantha* establishment was slower but was improved slightly by farmyard manure. Phosphate did not appear to improve establishment except in the case of Rhodes grass where there was some evidence that the phosphate applied at the time of planting the grass was beneficial. One notable observation was that in areas where there had been excessive soil wash, the establishment of Molasses and Rhodes was very poor.

The Kakamega trial was laid down rather late in the season and it is not yet possible to draw any definite conclusions from it.

Molasses Grass Grazing Trial (13 DM/1)

This trial at Kakamega was started in 1951 and reference should be made to the annual report for that year. The object of the trial was to study the effect on carrying capacity of Molasses grass of four different grazing rates. In 1952 it was decided that the system of grazing used in 1951 whereby each plot was rested for the same period as it had been grazed should be changed so that the length of each grazing period and resting period would be determined by the judgment of the A.A.O. On this basis grazing records were kept for each of the four one-acre plots from 1st May until 31st December, 1952, with the following results:—

Paddock	No. of animals	Grazing days	Animal grazing days
A	2	121	242
B	4	102	408
C	6	112	672
D	8	79	632

From this table it can be seen that the paddock grazed by six animals gave the highest actual carrying capacity on the basis of total animal grazing days, followed by the paddock grazed by eight animals, the four-animal paddock being third and the two-animal paddock fourth.

Detailed observation of the botanical composition of the herbage of each paddock at the end of the year showed that paddock A had maintained the best Molasses grass cover, followed by paddocks B, C and D, all a long way behind.

The actual figures for Molasses grass cover obtained by means of random transect counts were:—

Paddock	No. of animals	Molasses grass per cent cover
A	2	68
B	4	20
C	6	12
D	8	14

Paddocks B, C and D had become largely dominated by *Sporobolus* sp. and *Cynodon* sp.

Ley Species Palatability and Persistence Trial

This trial with eight ley grass species was started in 1950 and during that year was used for establishment studies. (*See* 1950 Annual Report.) During 1951 and 1952 palatability and persistence studies were done on the eight grasses. The 1951 results are given in the Annual Report for that year.

During 1952 the trial was grazed by cattle for four periods as follows:—

(1) January	18–21
(2) May	29–30
(3) September	8– 9
(4) December	30–31

As in 1951, palatability counts were done on each day of grazing by counting the number of animals grazing on each grass species at two-hourly intervals between 08.00 hours and 18.00 hours. The following table shows the total counts for each grass at each of the four grazing periods and the totals for the year and for the two years together.

Grass	Periods				Total 1952	Grand Total 1951 & 1952
	1	2	3	4		
Paspalum notatum ..	40	66	81	108	295	511
Paspalum dilatatum	53	121	94	60	328	566
Panicum makarikariensis	47	74	82	60	263	444
Molasses grass ..	66	69	89	74	298	432
Brachiaria decumbens	104	45	86	41	276	476
Rhodes grass ..	71	68	42	42	223	461
Mixed natural cover	102	119	120	92	433	675
Pemba grass ..	341	188	279	212	1,020	1,371

The main point of interest in these figures is the apparent very marked preference by the animals for Pemba grass which was even more marked in 1952 than 1951.

Grazing Capacity on Three Grass Species

This trial was started at Bukura in 1951 on three established fields of Molasses grass, Rhodes grass and *Paspalum dilatatum*, and records were kept of the number of animal grazing days given by each field (*see* 1951 Annual Report).

Similar grazing records were kept during 1952. The table below shows the carrying capacity (head per acre) of each grass over the year and the average over the two years of the trial:—

	Head Per Acre	
	1952	1952 and 1953 average
Molasses grass	1·76	1·46
Paspalum dilatatum	2·20	1·81
Rhodes grass	2·50	2·62

In considering these figures it should be pointed out that, at the end of 1952, the Rhodes grass field consisted of only about 40 per cent of this grass, so that it might be more correct to regard it as "mixed natural herbage"; the Molasses grass field consisted of about 60 per cent of Molasses grass and the Paspalum field was practically a pure stand of Paspalum.

Rice Variety Trial (23/1)

This trial at Namasaria (Kano) rice plots, near Kisumu, was to test the yield of 25 varieties of rice, which included six varieties already being grown in Nyanza or which had been included in previous trials, 16 varieties obtained from Ukiriguru in Tanganyika and three varieties obtained from Ceylon. The design was a lattice square design for 25 varieties with three replications, with plot size 1/80.7 acre. All the varieties were transplanted from seed-beds and grown under irrigation. The table below shows the yields of each variety, and the letters N, T or C alongside each variety indicate its origin as being Nyanza, Tanganyika or Ceylon respectively.

Table of Yields (Bags (of 160 lb.) of Dry Padi Per Acre)

Sindano	(N)	26·50	1/18	(T)	15·56
Faya	(N)	25·59	Afaa	(T)	15·40
Ambarikore	(N)	23·69	Kalafulu	(T)	13·47
Rathkayara 13753 ..	(C)	23·50	Bungala	(N)	12·97
B C 70	(T)	21·59	Joho	(T)	12·29
2/16	(T)	20·59	Bora Kupata ..	(T)	10·63
Sindano	(T)	20·31	Kihogo	(T)	10·23
Mbuyu..	(N)	19·65	2/9	(T)	9·80
Kikalasa	(T)	19·21	Suduheenati 1 CPY. 15	(C)	9·76
Afaa (My)	(T)	17·49	Gamti	(T)	9·11
Pishori	(T)	17·42	2/5	(T)	8·47
Maji Maji	(N)	16·32	Sinnanayam 2208 ..	(C)	7·14
			Kahogo	(T)	7·10

Significant difference at 5 per cent = 11.17.

Owing to the comparatively large size of the standard error, significant differences between varieties are insufficient to enable many definite conclusions to be drawn from this trial. It can, however, be said that there is no evidence that the variety Sindano (the commonest grown variety in Nyanza) is not at least as high yielding as any of the other 24 varieties, under the conditions of this experiment. As the milling quality of Sindano is also very high it would seem desirable to continue to encourage the planting of this variety in Nyanza, but not necessarily to the exclusion of other varieties. In 1953 it is proposed to lay down a more accurate variety trial on a small number of varieties.

Sugar Cane Variety Trials (29/2)

Two sugar cane variety trials had their first harvests during 1952: Firstly, a 5 by 5 Latin square trial of five promising varieties which was laid down at Miwani in 1950; and secondly, a trial of 16 promising varieties which was laid down in 1950 on Mr. Kala Singh's farm in the Indian farms area of Kibos, the design being a balanced lattice.

In the trial of five varieties at Miwani, plots were split for harvesting at two different times—March and May, 1952. The five varieties were: CO 421 (Kibos stock), CO 421 (Miwani stock), CO 281, CO 419, MF 240.

The table below shows the variety yields in tons of cane per acre:—

Variety	March harvest	May harvest	Mean of both harvests
MF 240	41·30	45·87	43·58
CO 419	35·62	49·55	42·59
CO 281	37·27	41·75	39·51
CO 421 (M)	36·62	41·85	39·24
CO 421 (K)	36·11	39·63	37·87

Variety differences as a whole were not statistically significant.

In the trial of 16 varieties, harvesting was done in August, 1952. The table below shows the variety yields:—

Variety	Yield tons of cane per acre
CO 331	58·76
CO 213	58·10
CO 419	48·10
CO 434	45·29
CO 408	43·81
CO 421	41·72
B 3337	41·21
CO 285	40·91
CO 432	38·34
MF 240	35·59
CO 417	34·98
CO 244	33·18
CO 281	31·07
POJ 2747	26·96
B 3257	22·17
POJ 2714	20·33

Sig. difference (5 per cent) = 20.04.

The experiment had to be analysed by the randomized block technique instead of the more efficient balanced lattice technique owing to the fact that one replication was too uneven to be harvested. Significant difference between varieties is therefore insufficient to enable many definite conclusions to be drawn from the trial. The trial has, however, enabled a smaller number of varieties to be picked out for testing in a more accurate variety trial.

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